MECHANICAL ENGINEERING

CHARLES PHELPS CUSHING

November 1941

A.S.M.E. ANNUAL MEETING—NEW YORK, N.Y.—DECEMBER 1-5, 1941

Steps in Engineering That Set Boiler Standard

PRESSURE *Developments*

1922
650 Pounds

B&W built first 650-lb. boiler and was making tests at pressures twice as high.

1923
1200 Pounds

B&W designed first 1200-lb. boiler for Edgar station—continued test work at pressures up to 5000 pounds with forced circulation.

1926
Two-Stage Boiler

B&W introduced Two-Stage Boiler having forced-flow stage or steaming economizer based on 1923 experiments. Later built 3500-lb. forced-circulation experimental boiler.

1931
Pressure Limit Tests

B&W concluded extensive tests on natural circulation in boilers at high pressures.

1937
2500 Pounds

B&W designed first 2500-lb. pressure natural-circulation boiler—a new high pressure in large-scale power generation.

WELDING and X-RAY *Developments*

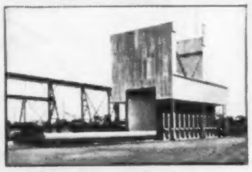
1930

First 200,000-volt X-ray machine for production inspection of welded boiler drums, placed in service early this year.

1930

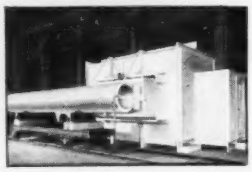
First welded boiler drums—for Navy cruisers—marks first approval of fusion-welded drums by an official engineering authority. (Bureau of Engineering, U.S.N.)

1931



Installed car-bottom type gas-fired stress-relieving furnace for stress-relief of welded pressure vessels.

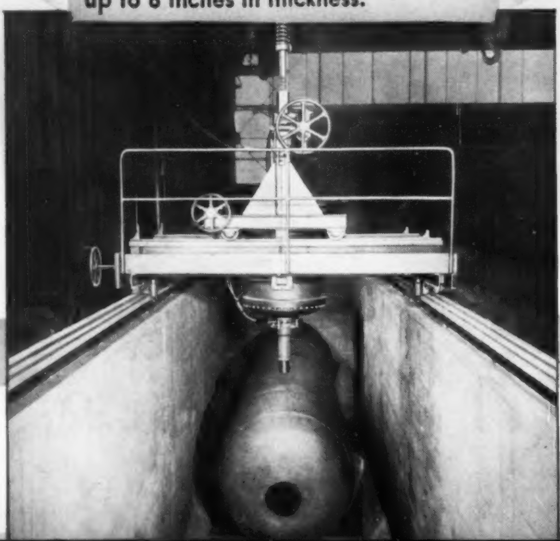
1932



First 300,000-volt X-ray machine — Permitting examination of welds more than 4 inches thick.

1941

First 1,000,000-volt X-ray unit placed in service—July 18, 1941—for inspection of welds in pressure vessels up to 8 inches in thickness.



FURNACE *Developments*

1926
Slag-Tap Furnace

Developed and introduced the first slag-tap furnace at Buffalo.

1929
Furnace Slag Screen

Applied furnace slag-screen to slag-tap furnace at State Line—a development that was the forerunner of the Two-Stage Furnace.

1932
Two-Stage Furnace

B&W introduced the Two-Stage Furnace and applied it to boilers at Buzzard Point and Richmond. In its latest form applied to, or on order for, 38 boilers.

1936
Open-Pass Boiler

B&W introduced large capacity boiler with open passes between furnace and convection heating surface to obtain extended operation with wider range of coals without slagging.

1937
B&W Radiant Boiler

B&W introduced the Radiant Boiler with Two-Stage Furnace and having practically no convection boiler heating surface.

BABCOCK & WILCOX

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Galloway, N. Y.

Cutter Grinding for Defense

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MECHANICAL ENGINEERING

November
1941

GEORGE A. STETSON, *Editor*

Winning and Losing the War

It is symptomatic of our times that more concern is expressed over postwar problems than over the outcome of the war itself. Reasons are not far to seek. There remains the memory of the victory of the Allies in the World War to bolster a robust faith that the enemy cannot win and the more recent recollection of the postwar depression that affected our people more personally and more acutely on the whole than fighting in Europe ever did. There haunts the minds of our generation the realization that the unemployment problem was never solved, but merely laid aside during the emergency employment in the National Defense Program. There also survive in acute form the tremendous expense, in terms of the national debt, of the efforts of the Administration to alleviate the distress of unemployment, and the rapid advance toward socialization of enterprise and institutions that is still going on. Added to this is the world ferment of change in political and social relationships, the meaning of which is not clearly understood and the end of which is nowhere in sight. No wonder our people whose greatest immediate concern is somehow to keep out of actual armed conflict and particularly to keep war out of the Western Hemisphere are in a mood to think more about ultimate consequences than they are to imagine a situation in which their own homes would be in danger of destruction and in which Axis powers would eventually come off the victor. Americans don't lose wars; but do suffer economic disaster and social change.

Both the interventionist and isolationist are one in desiring the speedy defeat of Hitler and the removal from the earth of the curse of Nazism. But they do not agree on the course to pursue. Likewise all intelligent persons admit the inevitability of a return of unemployment and of economic and social changes with the demobilization of postwar industries. Yet there is an understandable vagueness in predicting the exact form of such changes and in advocating measures to deal with them. A few positive-minded protagonists of extreme doctrines have programs to offer, but the more cautious and responsible citizen refuses to commit himself in any but general terms. From this it should not be imagined that the future does not concern him vitally or that he will not come forward with programs that are suited to the immediate conditions although not based on a long-range social and economic philosophy. He dislikes to stick his neck out and he has a shrewd appreciation of the fact that long-time plans "gang aft agley."

It was on this theme of winning the war today and tomorrow—abroad and in this country—that President Hanley spoke at the Louisville Meeting of the A.S.M.E. and that Walter White contributed ominous but challenging statements at the Management luncheon on the following day. Both appealed to engineers as patriotic citizens who believe in American traditions and as specially qualified members of society to prepare for postwar tasks and to exercise leadership in postwar affairs.

This dominant note was first sounded by W. L. Batt nearly a year ago at the 1940 A.S.M.E. Annual Meeting. It was almost simultaneously announced by C. E. Wilson, of the General Electric Company, at the Winter Convention of the A.I.E.E. and it has been persistently emphasized by President Hanley of the A.S.M.E. and President Prince of the A.I.E.E. in speeches made throughout the courses of their respective administrations. Thus a large segment of the engineering profession has been awakened to the challenge which faces it, to the credit of the broad-gage leadership of engineers themselves.

It would be fatuous to assume that to engineers alone must the nation turn for leadership in meeting the tasks that lie ahead. Numerically they represent an exceedingly small percentage of society. Politically they are weak and inexperienced and lack the organization required for effective action by a minority group. Strategically, as regards large areas of industrial, economic, and social influence they are well placed. Intellectually, they have the ability of analysis of realities which should be effective but which may not be entirely so with a majority of the electorate that succumbs so readily to flattery, wishful thinking, and absurd promises of demagoguery. Most effective would be a coalition of all educated groups—professional people, businessmen, the universities, and the church—and an intelligent collaboration with labor itself for a common front.

At first glance this formula appears to contain mutually exclusive terms and at best it represents simply national unity, yet how else, save through national unity, can the objective be reached? What engineers have to contribute to this coalition is their power of analysis, their ability to solve difficult problems, their inventiveness in devising new products and methods, their skill in production, their experience and art in the management of enterprises. Wisely employed these contributions would certainly insure the success of any plan upon which the nation could agree.

But again the catch lies in the word "wisely" and in the nature of the plan itself, because the contributions of the engineer are equally effective in a fascist or a communistic society as under a system of free enterprise. This Mr. White intimated, if he did not say it, in his address, for it was toward the maintenance of this sys-

tem that he called engineers to lead their fellow citizens. It is this that Mr. Hanley had in mind when he warned that we might win the war abroad and lose it at home. If we believe in free enterprise we must be willing to fight for it. If we want economic security we must count the cost. If we desire social progress we must contrive the design of its future pattern and assist in seeing that it is carried out. We must tear out alien philosophies before they are rooted in our own soil. Otherwise, even though democracy triumphs abroad it may languish and die at home.

Postwar Planning Now

ON page 814 of this issue appears a statement made by A. M. Selvey, of the A.S.M.E. Detroit Section to the Board of The Engineering Society of Detroit, urging action on postwar planning now. Mr. Selvey's statement was prompted by the suggestion of the A.S.M.E. Council that the local sections of the Society take to heart Mr. Batt's 1940 Annual Meeting address, "Through a Glass, Darkly," and institute programs in their communities to identify engineers with the problems that will inevitably follow postwar demobilization.

It was sound judgment that led the Detroit Section to place the matter before The Engineering Society of Detroit so that whatever program should be undertaken in that community would have the support of all engineers. And it is gratifying to note that on October 6 the Board of The Engineering Society of Detroit voted to appoint an exploratory committee to take preliminary steps in approaching the problem put before it by Mr. Selvey. Congratulations are in order to the Detroit Section, Mr. Selvey, and The Engineering Society of Detroit on the steps thus far taken and for the example thus set for other sections to emulate.

Confusion and Hope

CONFUSION tempered by hope is the impression one gets of the views of noted American scientists sent to the International Conference on Science and the New World Order held in London under the auspices of the British Association for the Advancement of Science.

President Conant of Harvard indicated that it was not fantastic to hope that in the not too distant future the scientists of all free countries may be joined in effective action to improve not instruments of war but those of peace. "Perfection of means and confusion of goals seem, in my opinion, to characterize our age," said Albert Einstein. In Ernest O. Laurence's statement "peace and justice over the world" was stated as being the greatest human need. Knowledge that plenty is available for all in this modern world, if thoroughly learned by men in all walks of life, would cause wars and uncertainties of life to disappear, according to Harold C. Urey. Frank B. Jewett reaffirmed his faith in unknown but immutable laws or principles of behavior, and wondered whether their discoverers "may not prove to be groups of able investigators who have banded together to secure the increased power of carefully focussed endeavor." And Harlow Shapley wrote that "the sooner it is commonly realized that either a world state or chaos and recession lies ahead, the sooner we can shape a program for scientists that appears constructive and is appropriately dignified."

Few of us there are who do not share the general sense of confusion and yet who have refused to abandon hope of better things to come. With the powerful tools of scientific knowledge and method in our hands, why should we not hope? Hope for what? Listen to Robert M. Hutchins speaking at the Fiftieth Anniversary Convocation of the University of Chicago:

"But no matter how we may struggle to deceive ourselves, we vaguely feel that bodily goods and external goods are not the ends of life. They are means to other goods beyond them. Now we no longer join in conscious or unconscious agreement on the nature and existence of the other goods beyond. The last half century has substituted confusion and bewilderment for the simple faith in which Mr. Harper, Mr. Rockefeller, and their collaborators embarked upon their enterprise at Chicago. That civilization which we thought so well established seems on the verge of dissolution. The religious belief which led the Baptists to found this university does not sustain its constituency today. Instead of feeling that we were born with a common inheritance of ideas about the purpose of the state and the destiny of man, we listen to competing affirmations of contradictory positions on these issues without being able either to accept or deny them in a manner satisfactory to ourselves. Confronted by the great question of peace or war, we cannot make up our minds what we want to defend, why, or how. Though the death rate is declining, we do not know what to do with our lives.

"Since we are confused about ends, we do not know how to employ means. Though our means of improving the material conditions of existence exceed those of any previous generation, we could not use them, in the great depression, to save our fellow-citizens from starvation and despair. The means of improving the material conditions of existence are now diverted to the extermination of mankind on a grander scale than ever before.

"If we are to do for our own day what the founders of the University of Chicago did for theirs, we shall have to continue what they did, and we shall have to do something more. We shall have to recapture, revitalize, and reformulate for our time the truths which gave purpose and significance to their work. We are in the midst of a great moral, intellectual, and spiritual crisis. To pass it successfully or to build the world after it is over we shall have to get clear about those ends and ideals which are the first principles of human life and of organized society. Our people should be able to look to the universities for the moral courage, the intellectual clarity, and the spiritual elevation needed to guide them and uphold them in this critical hour. The universities must continue to pioneer on the new frontiers of research. But today research is not enough either to hold the university together or to give direction to bewildered humanity. We must now seek not knowledge alone, but wisdom."

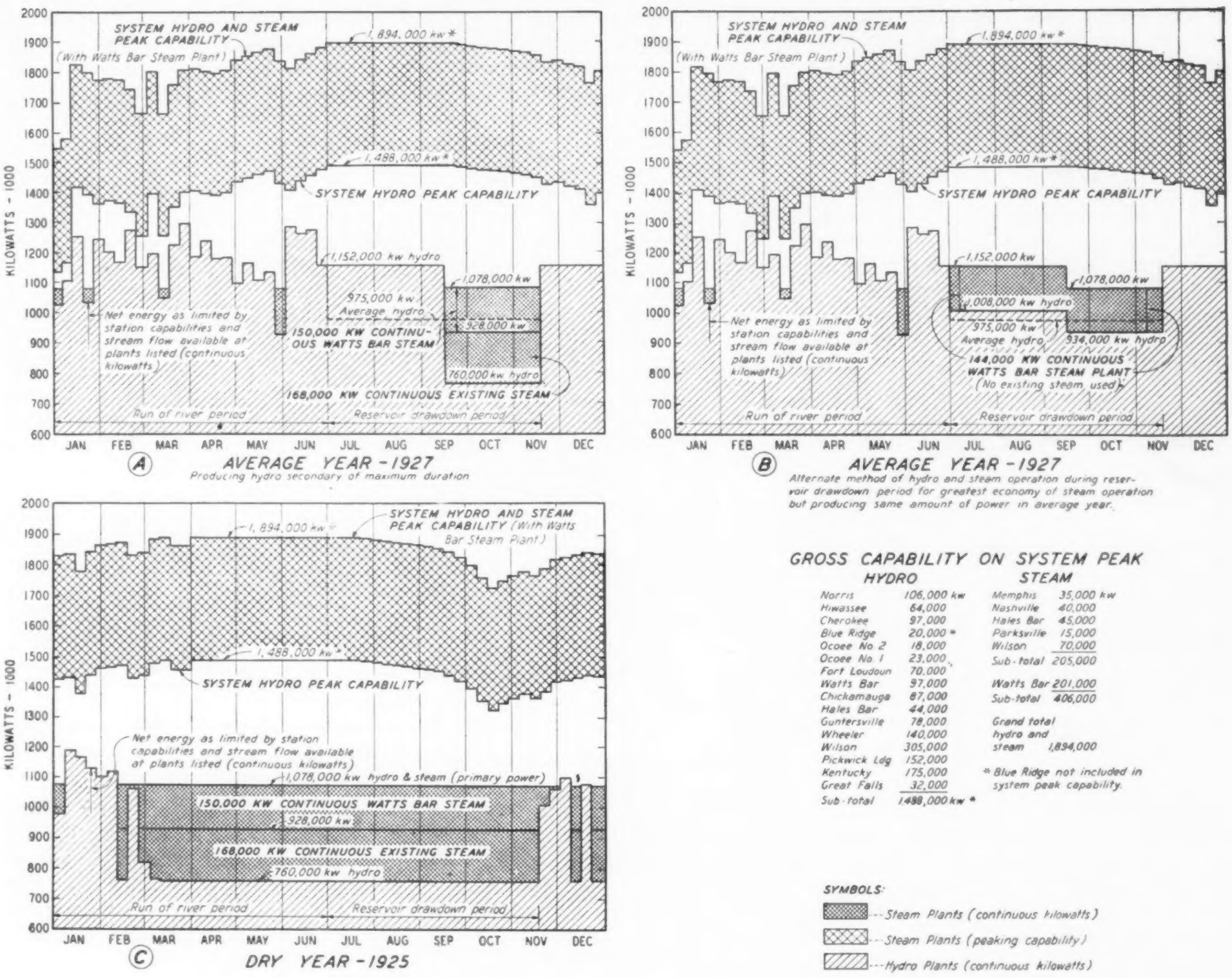

FIG. 1 POWER ADDED BY WATTS BAR STEAM PLANT TO 1944 TVA SYSTEM

The WATTS BAR STEAM POWER STATION *of the* TVA

By G. R. Rich[1] and R. T. Mathews[2]

As part of the program to insure an adequate power supply for the production of materials essential to the national defense, the Tennessee Valley Authority has under construction a steam power station of 180,000-kw capacity at Watts Bar Dam, near Spring City, Tenn. The first 120,000 kw of capacity was authorized July 31, 1940, for completion in February, 1942, and the remaining 60,000 kw was authorized April 5, 1941, for completion in October, 1942. When placed in service, this plant is expected to operate annually as a base-load station until the national emergency is past. The necessity of placing the first two units of this plant in operation as firm capacity in approximately 18 months after authorization by Congress made the time element a controlling factor in design. Major equipment was selected from proved designs offered by the manufacturers, in order to reduce to a minimum the interval required for fabrication and erection, and to obviate the necessity for inevitable tuning of innovations in designs, thus insuring the continuous provision of firm power in the shortest period of time.

The economic design of the station and the selection of

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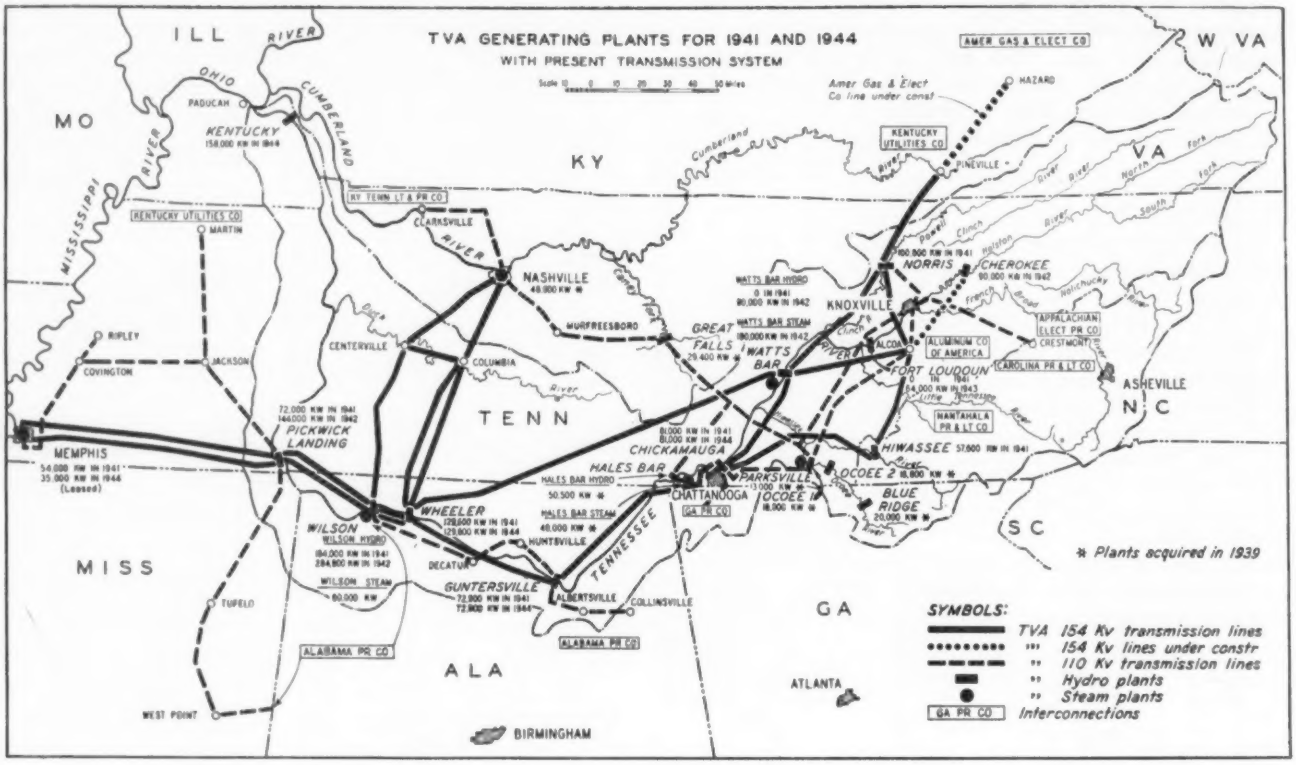

FIG. 2 THE TENNESSEE VALLEY AUTHORITY POWER SYSTEM

major equipment were also influenced by the more permanent use of this steam-power capacity as part of a large predominantly hydroelectric system, without reference to existing emergency conditions. According to present plans, in connection with the Authority's program for navigation and flood control in the Tennessee Valley, the power system, in 1944, will have a total installed hydroelectric rated capacity of 1,408,000 kw and an approximate total steam capacity of 380,000 kw, of which 200,000 kw has been obtained by acquisition or lease and 180,000 kw is to be added by the new steam plant.

Fig. 1 shows the predicted net energy generation of steam and hydroelectric capacity in 1944, for both an average and a dry water year, as limited by station capabilities and stream flow available at the plants listed. It is estimated that the hydroelectric plants will be capable of producing 760,000 kw of primary energy and approximately 390,000 kw of secondary energy, available 75 per cent of the time during the average water year. The existing steam plants, after a reasonable allowance for plant auxiliaries and occasional outages, are to convert 168,000 kw secondary into primary energy, and the new steam plant is to prime 150,000 to 180,000 kw of the remaining 220,000 kw of secondary energy. However, as the TVA system is composed of both run-of-river hydroplants and reservoir-storage plants such as Norris, Hiwassee, and Cherokee, it is possible to control the river flow during the reservoir draw-down period for more average hydrogeneration.

It will be noted in Fig. 1(*B*) that the steam capacity can be reduced approximately one half by proper river control and longer operation of the Watts Bar steam plant. This method reduces to a minimum the operation of low-efficiency existing steam plants during an average water year. It will also be noted in Fig. 1(*C*) that during extremely dry years the energy from all steam plants may be required for as many as 37 consecutive weeks. During wet years the steam-generating capacity is contemplated for peaking during high-water-flow periods and little generation at other times is anticipated. Steam capacity is required during high-water-flow periods for peaking because of the loss of head at run-of-river plants. The low points in the system hydropeak-capability curve for the average water year in Fig. 1(*A*) indicate the loss in hydrocapacity during the first 3 months, because of high-water flow. During extreme high-water flow, it is predicted that hydrocapability may be reduced by over 300,000 kw, and it may be necessary to replace this loss of capacity by steam units to meet load requirements. It is thus estimated that, on the average, over a long period, the Watts Bar steam plant will be operated for approximately 45 per cent of the time or approximately 4000 hr annually.

It will be noted in Fig. 1 that the system hydropeak-capability curve exceeds the continuous kilowatt-energy curve of steam plants and hydroplants, with the exception of short high-water-flow periods, by an excess of 150,000 kw. As idle hydrocapacity is available whenever the steam plant is in operation, outages of steam units are not so serious as in a predominantly steam-powered system. This factor has been duly considered in the design and selection of equipment for the steam plant.

PLANT SITE AND SIZE OF UNITS

The TVA power system is shown in Fig. 2. An investigation of the load demands of the system indicated a deficiency of power in the East Tennessee area, and the resultant better balance in the use of existing transmission-line capacity narrowed the selection of a site to this section. The site selected at Watts Bar is approximately 3500 ft downstream from the dam and hydroplant. The advantages of this site, shown in Fig. 3, are numerous. Good-quality East Tennessee and Kentucky coals are available at lower cost, on a heating-value basis, than coal in other load-center areas of the TVA system. Sufficient cooling water is available during any period of the year from the Watts Bar reservoir. A short transmission line of 3500 ft will tie the steam plant into the existing transmission system which has adequate line capacity to most of the major load centers, as will

be noted in Fig. 2. The use of the Watts Bar site also reduces the construction cost, owing to its proximity to the Watts Bar Dam construction area. This makes possible the use of the same machine shops, construction equipment, access highway, and railroad for both projects. Finally, the topographic features and foundation conditions of the site were found to be good.

Units of 40,000- and 60,000-kw capacity were considered, but the larger units were chosen because of the lower first cost of equipment and building required. A 60,000-kw unit does not greatly affect the spinning- or stand-by-reserve requirements of the system, because the largest hydroelectric unit is rated at 57,600 kw at Hiwassee, and the largest steam unit is rated at 60,000 kw at the Wilson steam plant. Moreover, the same importance does not have to be attached to the effect of large steam units on spinning-reserve requirements in a predominantly hydroelectric system as is necessary in a steam system with little hydroelectric capacity. In the TVA system, spinning reserve is very inexpensive because some hydrounits not needed for energy are motored as synchronous condensers. Operating in this manner, these units require only a few second-feet of water for cooling and seal lubrication, and, in the case of the turbines at Norris, have picked up full load in 8 sec, as the result of power interruptions.

Since steam capacity in the TVA system is used primarily to supplement hydroelectric energy, and as peaking capacity only, during high-water-flow periods, the size of steam units, within reasonable limits, will not affect the operating cost of spinning reserve or the initial cost of providing adequate stand-by reserve for the hydrosystem. It will be noted in Fig. 1, that forced outage of a steam unit will not decrease the ability of the system to meet the load demand, since hydrospinning reserve will take over the deficiency in steam generation. The only effect on system operation of a forced outage of a steam unit will be the depletion of reservoir storage below scheduled operating level. However, this can be restored by operating the steam unit for a longer period or at greater load when returned to service. The only exception to this will occur during flood periods when the capacity of run-of-river plants is greatly reduced, due to low head, and steam power is used for peaking. In view of these considerations, larger steam units, which will reduce the initial cost over smaller units, have been selected.

STEAM GENERATOR AND ACCESSORIES

The steam generator and arrangement of accessories are shown in Figs. 4 and 6. This unit is designed for 600,000 lb of steam per hr, with steam conditions at the superheater outlet of 900 psi and

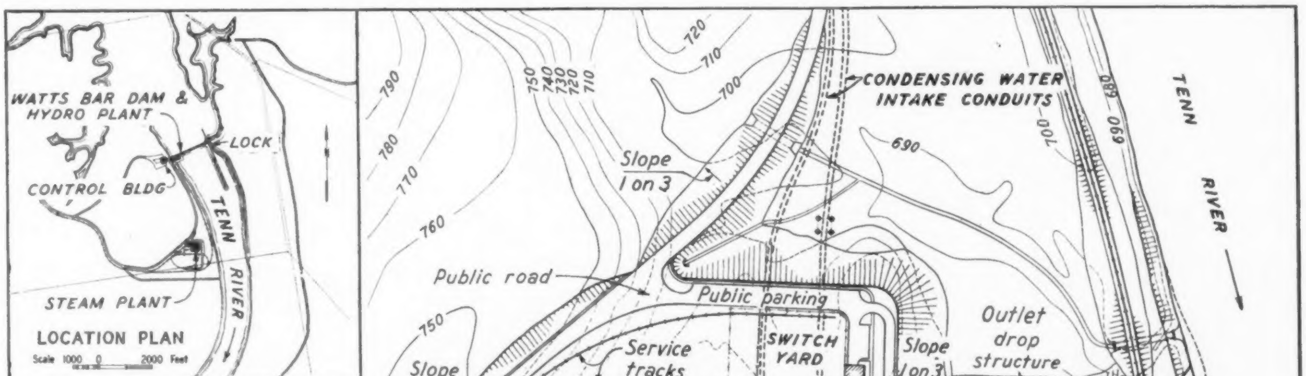

FIG. 3 GENERAL PLAN OF WATTS BAR STEAM-PLANT SITE

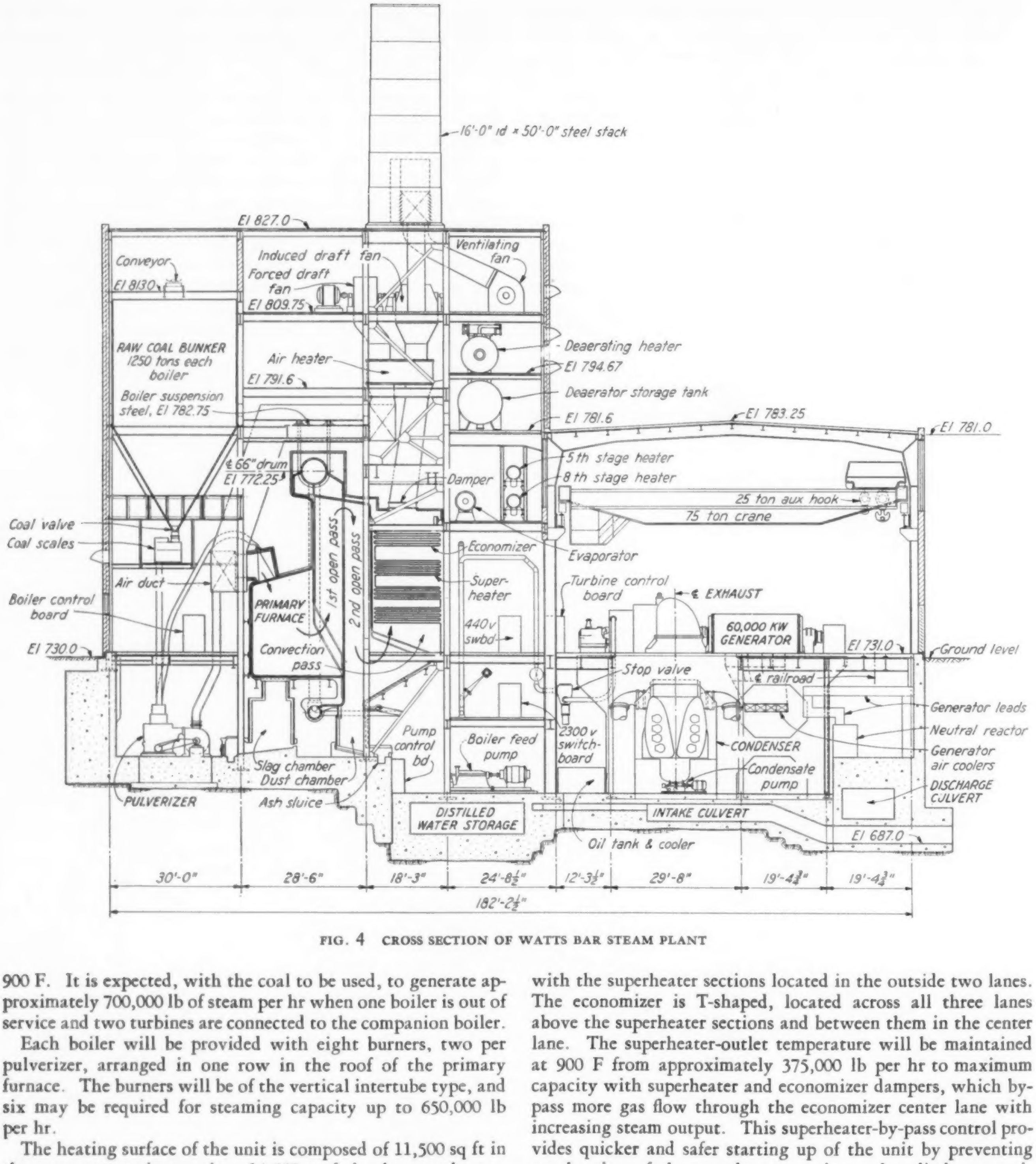

FIG. 4 CROSS SECTION OF WATTS BAR STEAM PLANT

900 F. It is expected, with the coal to be used, to generate approximately 700,000 lb of steam per hr when one boiler is out of service and two turbines are connected to the companion boiler.

Each boiler will be provided with eight burners, two per pulverizer, arranged in one row in the roof of the primary furnace. The burners will be of the vertical intertube type, and six may be required for steaming capacity up to 650,000 lb per hr.

The heating surface of the unit is composed of 11,500 sq ft in the steam-generating section, 14,660 sq ft in the superheater, and 20,820 sq ft in the economizer. Two regenerative-type air heaters, having a total of 90,000 sq ft of surface with provision for warm-water washing, are provided per unit. Two 25-in-diam pipes from each end of the steam drum, external to the boiler casing, feed the lower waterwall headers to provide maximum natural circulation. The steam drum is equipped with cyclone separators and steam scrubbers to reduce the total of carry-over solids in the steam to not over 1 ppm at all loads up to the design capacity of the unit, with a maximum concentration in the boiler water of 1250 ppm.

The rear pass of the unit is divided into three separate lanes with the superheater sections located in the outside two lanes. The economizer is T-shaped, located across all three lanes above the superheater sections and between them in the center lane. The superheater-outlet temperature will be maintained at 900 F from approximately 375,000 lb per hr to maximum capacity with superheater and economizer dampers, which by-pass more gas flow through the economizer center lane with increasing steam output. This superheater-by-pass control provides quicker and safer starting up of the unit by preventing overheating of the superheater sections when little steam is being generated. Because of this increased gas flow through the economizer section at the higher outputs to maintain superheater-outlet temperatures, some steaming occurs in the economizer tubes at the normal rating of 600,000 lb per hr.

The mechanical-draft equipment consists of two duplex fan units per boiler, driven from the forced-draft-fan end by a 720-rpm constant-speed 800-hp motor. Although this is primarily a base-load plant when operating, induced-draft fans are provided with inlet-louver control, and forced-draft fans have inlet-vane control to accommodate varying load with better power economy than could be obtained by damper control.

At the rated capacity of 600,000 lb per hr of steam, these units are designed to have an efficiency of 88 per cent, a draft loss of 12.9 in. of water, and a flue-gas temperature leaving the air heater of 328 F. At this same rating, the flue-gas temperature entering the superheater and economizer banks is 1895 F, and leaving the economizer, 665 F. Secondary air is supplied to the burners at 550 F, and the furnace liberation is 27,000 Btu per cu ft per hr at 600,000 lb per hr steam output.

THE TURBOGENERATORS

The turbine will operate at 1800 rpm and has been designed for steam conditions of 850 psi gage, 900 F, at the throttle, and 2 in. of mercury abs back pressure at the condenser. The machine is of the single-cylinder impulse design, having seventeen stages with extraction from the fifth-, eighth-, eleventh-, and fourteenth-stage shells for feedwater heating. The turbine has fourteen control valves, equally divided in the upper and lower shells. The first ten valves admit steam to the first-stage nozzles and the last four valves by-pass steam from the first-stage shell to the third stage, to increase the steam flow through the turbine for generator outputs above approximately 58,000 kw. This valve arrangement results in a relatively flat steam-rate curve between 40,000 kw and full generator output.

Turbine auxiliaries consist of one oil cooler, a motor-driven auxiliary oil pump, a turning-gear motor, and a-c and d-c motor-driven turning-gear oil pumps. In case of auxiliary-power failure, the station battery will supply energy to the d-c motor-driven turning-gear oil pump, which will maintain oil pressure to the turbogenerator bearings while the unit is slowing down with the turbine stop valve closed, and the speed too low for the main oil pump to be effective.

The turbine stop valve will be automatically tripped by low condenser vacuum, thus eliminating the atmospheric relief valve and piping. An explosion diaphragm is provided in the top of the turbine exhaust hood for protection against possible failure of the automatic equipment.

Each generator is rated 60,000 kw, 0.9 power factor, 66,667 kva, 3 phase, 60 cycles, 13,800 v and has a direct-connected exciter, and a pilot exciter. The air-cooled generators will be protected against fire by CO_2 extinguishing equipment.

CONDENSER

The condenser for each unit is designed to condense 400,000 lb of steam per hr with 85 per cent clean tubes, when 70,200 gpm of water is circulated at 76 F, with a resulting pressure of 1.8 in. of mercury abs. The condensers are of the single-pass divided-water box type, containing 40,000 sq ft of surface, composed of $^7/_8$-in-OD 18 BWG tubes, having an over-all length of 26 ft. The water boxes and covers are divided so that one half of the tubes may be cleaned while the other half are in service. The tube-sheet layout is divided into two relatively shallow tube banks, so arranged as to provide a large free opening between these banks for longitudinal distribution along the entire tube length, and also to permit an increase of pressure in the hot well for reheating and deaerating the condensate.

Gravity flow of cooling water through penstocks from above the dam to the condensers was selected in preference to circulating pumps. Pumping costs, as compared with the cost of hydroenergy lost by gravity flow through the condenser, did not warrant the use of circulating pumps. A factor, influencing the selection of gravity flow of condenser cooling water, was the possible variation of 43 ft in tail water at Watts Bar. If circulating pumps were used with such a variation in river level, the necessity of providing a very deep condenser pit would have increased considerably the building-substructure and turbine-foundation costs.

Cooling water from the reservoir will pass through two 6.5-ft-diam precast reinforced-concrete pressure pipes for an ultimate installation of four condensers. A closed circulation system from the reservoir to a common condenser-discharge canal will be maintained by the outlet-drop structure, shown in Fig. 3. This outlet-drop structure or weir will maintain a water elevation in the canal of 699 ft for normal operation, and, with a reservoir variation from elevation 733 to 745 ft due to river control, the head available for the condensing-water system will vary from 34 to 46 ft. During periods of extreme flood, the tail water will reach 718 ft and the head for the condensing-water system will drop to 27 ft, at which time the differential head available across the condenser will be approximately 10 ft. The condensers have been designed to operate satisfactorily under these extreme flood conditions because the steam-plant capacity will be used for system peak load at such times. The water flow through each condenser will be controlled by two butterfly valves on the discharge side of the unit. These butterfly valves are motor-operated with low gear ratio, in order to prevent damage to the condenser from water hammer, resulting from sudden closing of a valve.

HEAT BALANCE

Fig. 5 shows the heat-balance diagram for one unit. The plant is designed on the unit system with cross connections for the main steam and boiler-feedwater systems for emergency use only. These cross connections will only be made between the first two units. The third unit will not be cross-connected with the first two units but will be cross-connected to a future fourth unit.

Steam conditions of 850 psi, 900 F were selected as most advisable, because the low fuel cost, and normal low annual hours of predicted operation placed a limit on the initial expenditure which could be made in high-pressure and high-temperature equipment to reduce fuel costs.

The fifth- and eighth-stage heaters are designed for 1500 psi water pressure, with duplicate tube bundles and integral drain coolers for subcooling the drains below the saturated-liquid temperature. The feedwater will by-pass these heaters as a unit, because their outage will only lower the plant efficiency, as the boiler has sufficient spare capacity in fans, pulverizers, and heating surface to maintain turbine output at the lower feedwater temperature. The eleventh-stage heater is an open deaerating heater with a 12,000-gal storage tank located below to act as a surge tank for the complete steam-and-water cycle. The fifth- and eighth-stage-heater drains will be returned to the deaerator over the heater trays to insure complete deaeration during the starting up of a unit. It will be necessary to use an eighth-stage-heater drain pump during starting-up periods when the eighth- and eleventh-stage pressures are approximately the same, because the higher-stage pressure heaters and evaporator are located on a lower floor level than the deaerator.

The evaporator make-up will be treated Tennessee River water which will be heated in a separate preheater before entering the evaporator shell. The deaerating heater will be used as the evaporator condenser, if the feedwater is by-passed around the fifth- and eighth-stage heaters. The same connection to the deaerator will also be used to increase the capacity of the evaporator, by reducing the shell pressure, when the plant has been started up after a shutdown period, and distilled water is required to refill the condensate-storage tanks. These are 40,000-gal concrete tanks with a carbon brick lining located below the basement-floor level, and will be used to store the boiler water and feedwater in the piping system and equipment during long shutdown periods. During plant operation, these tanks will serve as an emergency supply of condensate.

All plant auxiliaries are electrically driven. Each boiler has only one motor-driven boiler feed pump. One spare motor-

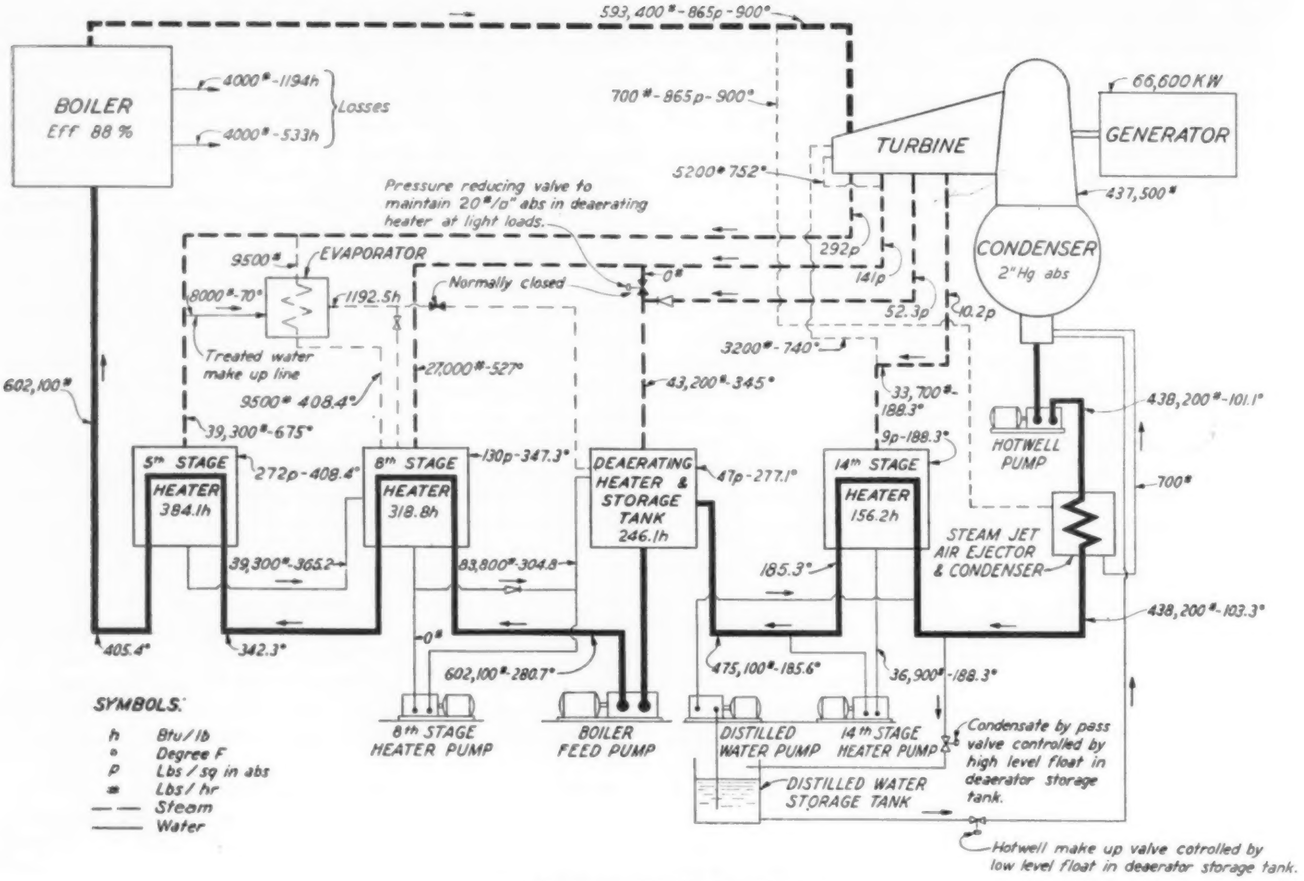

FIG. 5 HEAT-BALANCE DIAGRAM

driven pump is provided for two boilers. The feedwater piping is so arranged that any pump can be used with either boiler. In general, spare equipment is limited to those auxiliaries essential to the protection of the major equipment. These include boiler-feedwater pumps, condensate pumps, and turbine-lubricating-oil pumps.

A net plant heat rate of 11,800 Btu per kwhr at 66,600-kva generator output, and 2 in. of mercury abs condenser back pressure is expected. This heat rate is based on manufacturers' guarantees and includes allowances for auxiliaries and other losses. Condenser back pressure has been based on predicted summer reservoir-water temperatures.

COAL HANDLING

The plant layout, shown in Fig. 3, is designed to receive coal by rail, and provision has been made for the possible future installation of a barge-unloading terminal and conveyer to the main handling system. A 70,000-ton-capacity rotary car dumper, designed to unload a minimum of 10 cars per hr, will be provided for one track in the hopper building. The second track through the hopper building will provide for bottom dumping of cars only.

The coal-storage yard will have a capacity of about 200,000 tons, or over 2 months' supply, for the ultimate station. A drag scraper will be used to distribute and reclaim coal from the storage yard. The coal-handling equipment will have a capacity of 400 tons per hr, and each boiler will have a bunker capacity of 1200 tons, or about 40 hr at rated capacity.

ELECTRICAL EQUIPMENT

The generator voltage will be stepped up to 154 kv by unit-transformer banks through oil circuit breakers at the steam-plant switchyard. A short transmission line will connect this switchyard with the main 154-kv switchyard near the hydroplant. Oil circuit breakers at this point will be arranged to connect each steam-plant unit to either of the two 154-kv buses which tie into the Authority's main transmission system, shown in Fig. 2. The main switchyard, now designed for 270,000 kw of generating capacity, consisting of three hydrounits and three steam units, will have an ultimate capacity of 390,000 kw with two additional hydrounits and one steam unit.

All electrical controls for the generators of the two Watts Bar plants, and for the breakers and switches of the high-voltage switchyard, will be brought to a control benchboard in the control building adjacent to the switchyard. This building is on a bluff overlooking the hydroplant, and approximately 3500 ft upstream from the steam plant. All control circuits will operate on 250 v direct current and will be supplied by a station battery and two motor-generator charging sets. Emergency direct-current lighting will be provided in the operating areas and will be a part of the normal lighting system.

Three 7500-kva 13,800-2300-v station-service transformers are connected through motor-operated disconnecting switches to the low side of each power-transformer bank. Three 2300-v distribution boards will supply power to all the larger auxiliaries and to three 750-kva 2300-440-v transformers, which in turn will supply the smaller motor-driven auxiliaries. Normally, each unit will be operated independently of the others with no ties between the auxiliary power buses. Automatic transfer equipment is provided, however, for connecting the 2300-v or 440-v buses of adjacent units through bus tie breakers, in the event of loss of voltage on any bus. Each of the auxiliary transformers will have ample capacity for carrying normal

essential auxiliaries for two generating units. A separate source of 440-v power will be obtained, when the steam plant is shut down, from a 600-kva transformer connected to a local 12-kva rural line.

CONTROLS

Turbine, boiler, and pump control boards are provided for the unit operation of each steam generator, turbine, and auxiliary equipment. The turbine-board instruments include an eccentricity recorder, a vibration-amplitude recorder, and a speed and camshaft-position recorder to aid in turbine operation, and to provide safer and quicker starting of the turbine after long shutdown periods. As gravity flow will be used through the condenser, the control of water flow for each tube bank is placed on the turbine board with necessary flow indicators.

All controls for the feedwater cycle from the hot well up to the boiler-feedwater regulator are centralized at the pump control board. Also, local control is furnished for all pumps and valves. An annunciator system and interplant telephone at each control board provides means of quick communication between control points.

Automatic combustion control, feedwater control, and superheat control have been installed for each steam-generating unit. Automatic boiler feed pump recirculation to the deaerating heater at low flow through the pump will be used to safeguard the pumps against damage from overheating. The spare boiler-feed-pump motor will be started by low differential pressure across either feedwater regulator to the two boilers it will serve. Automatic controls will close the necessary valves after the spare pump is started, so this pump will serve only the boiler requiring the additional feedwater flow or whose normal boiler-feed pump has developed trouble. Failure of the boiler-feedwater pumps will automatically trip all pulverizers. Automatic controls are provided to by-pass the feedwater around the fifth- and eighth-stage heaters, which are on the discharge side of the feedwater pumps, in case of high water level in either heater shell, resulting from tube leakage or any other cause. Automatic starting of one 400-gal distilled-water pump is provided for, due to emergency low water in the deaerator storage tank. A second pump can be started manually.

Although automatic control will be used for maintaining plant efficiency, or to provide added protection for major operating equipment, manual control of all equipment is provided for, so that failure of any or all automatic equipment will not prevent safe continuous operation of the plant.

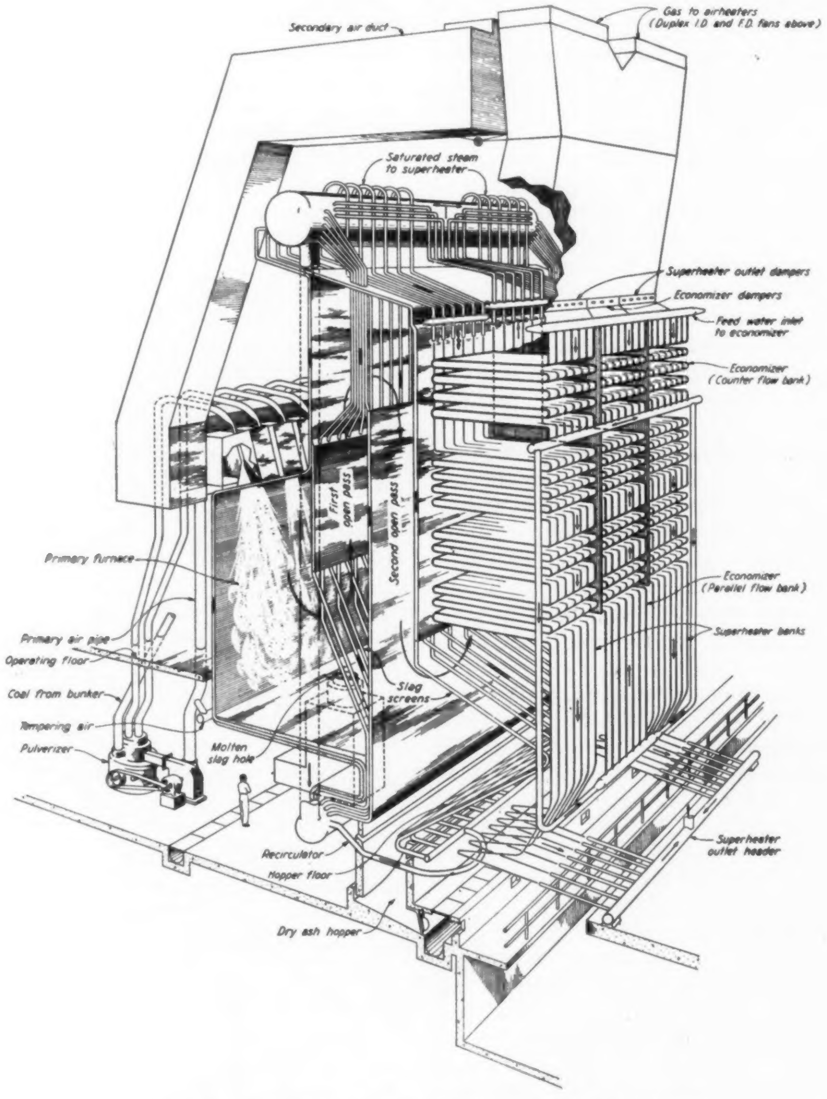

FIG. 6 WATTS BAR STEAM GENERATOR, 900 PSI, 900 F

FUELS *and* LUBRICANTS *in* NATIONAL DEFENSE

By C. M. LARSON

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BECAUSE of its size, diversity, speed, and urgency, the National Defense Program presents a fuel and lubrication problem unparalleled in the entire history of servicing, operation, and maintenance of mechanized equipment. Today's highly developed mechanical units present special problems of fuels and lubricants calling for the use and application of specific types of petroleum products. When this equipment is applied to National Defense use by the Army, it is subjected to the most severe service. Operating efficiency under all circumstances and utmost simplification of the fuel and lubricant requirements are desired.

Industry, which furnishes the great bulk of the National Defense motorized and armored equipment, requires that each manufacturer's equipment be fueled and lubricated with his own list of petroleum products. This creates an objectionable feature owing to the necessity of stocking several different grades of fuels and lubricants for similar machines or engines from different manufacturers. Various governmental departments and branches of the services approached the problem of standardization through specifications, testing, and purchasing, but their first efforts only added to the confusion. Only through cooperative planning of all—industry, Army, Navy, and Federal agencies—can the fullest utilization of fuels and lubricants be had through standardization. Then the Quartermaster Corps can keep the lowest possible inventory of grades and sizes of metal packages and the maximum distribution efficiency can be effected without error in handling and in servicing this National-Defense equipment.

On July 1, 1941, the Army had approximately 170,000 motor vehicles in service, exclusive of motorcycles, and approximately 25,000 motor trucks a month are rolling off the assembly line to fill the Quartermaster Corps' estimated requirement of 250,000 vehicles, including 40,000 motorcycles, for an army of 1,400,000 men. These units in maneuvers average about 35 miles per day and generally each group of 200 to 260 vehicles is in charge of a motor officer. In addition to the fuel and lubricant requirements of these motorized divisions, there are to be four armored divisions, each to be composed of approximately 3400 vehicles including tanks. On the road an armored division uses approximately 1000 gallons of gasoline per mile. Besides this equipment the Air Service airplanes and vehicles add to the fuel and lubricant requirements, not to mention shops, guns, railroad equipment, and stationary gasoline and Diesel lighting sets operated by the War Department.

The original Quartermaster Corps lubrication chart for 1940 and 1941 vehicles applied to 26 makes of trucks, five makes of passenger cars, and two makes of motorcycles—a total of 93 different models in all. This chart tabulated the vehicle-manufacturers' recommendations for lubricants based on S.A.E. viscosity numbers and N.L.G.I. (National Lubricating Grease Institute) grease-consistency grade numbers only (quality was a separate consideration).[1] Such products are to be used in the engine, air cleaner, transmission, transfer case, front and rear differentials, steering gear, propeller-shaft universal joints, chassis, and wheel bearings, not to mention the entire range of temperatures and climatic range; but this demand for 17 oils and greases was impractical. The 15 lubricants required of the tank also complicated the situation further, not to mention fuels. The U. S. Navy specifications and contract cover the War Department lubricating-oil and motor-oil needs, the Procurement Division Treasury Department some of the specifications and multiple awards for greases and gear oils. The National Bureau of Standards specifications through the Federal Specification Board, the Ordnance Department, the Quartermaster Corps, the Air Corps also have specifications and contracts for related petroleum products. This sounds out of hand, but let's see the progress made to date and future standardization planned in the War Department whereby the fuels and lubricant requirements of the National Defense equipment for the motorized and armored divisions and other field forces are reduced to a practical, feasible number.

GASOLINE

The five grades of gasoline have been reduced to the 80 and 100 minimum-octane-number classification of grades. The 80 octane is to be used for all vehicles, tanks, and cookstoves, whereas the 100 octane is for aviation. This means that motor vehicles will have to be tuned up on 80 octane by spark and carburetor adjustment or else exhaust-valve stems will burn and cookstoves will need to be redesigned for leaded fuel instead of the use of water-white product. The CFR Committee has cooperated with the Ordnance Department so that instead of losing 30 per cent of the horsepower of the tank-engines output when 80 octane had to be used instead of 87 octane, only 10 per cent loss was experienced through adjustment and redesign.

The CFR Committee also has investigated starting at low temperature and the octane requirement and the vapor-pressure needs of gasoline at high temperatures for the tank. To meet the requirements of the 100-octane aviation demand of the British and also in the future here, the new 3*C* knock-test method was developed whereas the 1*C* method still holds for aviation

Presented at the National Defense Meeting, St. Louis, Mo., Sept. 9–11, 1941, of The American Society of Mechanical Engineers.

[1] The National Lubricating Grease Institute (N.L.G.I.) classification of lubricating greases by the A.S.T.M. worked consistency became official on March 1, 1941. This grease penetration range is comparable to the Society of Automotive Engineers' classification of crankcase oils by viscosity. The classification follows

N.L.G.I. grade	A.S.T.M. worked penetration
No. 0	355–385
No. 1	310–340
No. 2	265–295
No. 3	220–250
No. 4	175–205
No. 5	130–160
No. 6	85–115

gasoline up to 100 octane. This too was accomplished by CFR and industry in cooperation with the Air Corps and Navy.

DIESEL FUEL

Inasmuch as the armored force is using some Diesel engines in tractors, the Diesel-fuel requirements of such engines as the Caterpillar, G.M.C. 71, and others had to be considered. The Navy Diesel Fuel Specification 7-0-2 (INT), or its equivalent, is the basis for a 50 minimum cetane Diesel-engine fuel furnished in one grade only.

LUBRICATING OIL, GASOLINE ENGINES

The vehicles and tanks of the motorized and armored divisions are standardized by the War Department Liquid Fuel and Lubricant Committee around S.A.E. 10, 30, and 50 engine oils. The S.A.E. grade 30, whether Navy symbol (N.B.S. 431 U. S. Navy)[2] 3065 or 1065 oil, is used for all trucks, passenger and combat cars, air cleaners, and in fact practically every type of engine except motorcycle, tank, and Diesel engines. The motorcycle engine is to use S.A.E. 50, Navy symbol 1100, and the tank engine as redesigned is to use this same 1100 oil. As to aircraft engines, the Air Service still uses S.A.E. 60, Navy symbol 1120 (*B*), whereas the Navy Bureau of Aeronautics specifies Navy symbol 1100 (*A*), the same as for the motorcycle and tank engines of the War Department. For temperatures below +10 F cold-starting temperatures, S.A.E. 10, Navy symbol 1042, is available for trucks, combat, and passenger-car engines. The Packard Rolls Royce aircraft engine specifies the Navy symbol 1100 oil (*A* or *B*); *A* requires Navy work-factor test; *B* requires Air Corps oxidation test.

LUBRICATING OIL, DIESEL ENGINE

For Diesel engines, the heavy-duty additive types of oil having jointly Caterpillar certificate and G.M.C. 71 recommendation for test and service are to be used for tractors and stationary Diesel engines in the War Department. S.A.E. 30 grade will be used above +10 F and the 10 grade below this cold-starting temperature. The War Department has no means for testing and approving such heavy-duty Diesel-engine lubricating oils, whereas the Bureau of Ships, Navy Department, tests these oils over 300-hr periods on at least five makes of Diesel engines, including full-scale submarine-type Diesels. This type of Navy-approved oil, S.A.E. 30 grade, is recommended for all Diesel engines afloat. Industry will be required to test Diesel engines on this grade and type of approved oil.

LUBRICATING OIL (TRANSMISSION, DIFFERENTIAL, TRANSFER CASES, FINAL DRIVE)

In the transmission, differential, and final drive of the tanks the disposition is to use the same Navy symbol 1100 oil, S.A.E. 50, as used in the tank radial-type engine, so that only one type of oil is needed. However, for vehicles with hypoid gears, truck and passenger-car service, spur gears, and others too numerous to chart, the Universal Gear Lubricants Federal Specification No. VV-L-761, covered by Treasury TPS class 14 contracts,[3] is to be used. These oils are built around Navy symbol oils plus 10 per cent of approved film strength or E.P. (extreme pressure) additives. This type of universal gear oil reduces error to a minimum. There has been some thought that these additive types of gear oil permit a hotter transfer case, but actual field-service tests show the opposite, or temperatures 25 to 30 F cooler. Cases are known in which the transfer-case temperature is as high as 300 F, but this is more often the effect of a transfer case that is too full or without any oil. Scuffing of gears has definitely been eliminated with the universal type of gear oil. There are class 1 (S.A.E. 80), class 2 (S.A.E. 90), and class 3 (S.A.E. 140) universal gear oils. The testing of a class 2–3 (S.A.E. 90–140) oil to replace two grades appears to be possible. However the War Department Committee on Liquid Fuels and Lubricants recommends class 1 for temperatures below +10 F and class 2 for higher-atmospheric-temperature operations. See Table 1. Better cooling of final drives, transmissions, and transfer cases is needed in order to standardize gear lubricants successfully. Also steering-gear manufacturers recommending S.A.E. 250 gear oils are out of order.

CHASSIS LUBRICATING GREASE

The Quartermaster Corps has established a chassis lubricant (Q.M. Specification ES-444 Revised) around a soda-soap grease of N.L.G.I. No. 2 penetration grade with the view of using it not only for pressure fittings, steering drive ends, and universal joints, other than needle bearings, but also for wheel bearings as well. For tanks the Ordnance Department used an aluminum or lime grease for sponson mounts, track, and suspension system for the field, whereas Rock Island Arsenal recommends a soda-soap grease (AXS-422B), Chrysler and American Car and Foundry are following Rock Island Arsenal's recommendation, whereas Baldwin Locomotive is using the Ordnance Department field-service recommendation of lime-soap type for chassis lubrication. The new lubrication charts for these tanks in field service specify one chassis grease for summer and one for winter for all purposes such as sponson mounts, track, and suspension systems, as well as ball and roller bearings. This is in accordance with the desires of the War Department Committee on Liquid Fuels and Lubricants. See Table 1. The use of graphite grease on radial-type-engine accessories has been done away with and the need of a high-temperature grease for rocker arms was dispensed with when the engine was fully lubricated with crankcase oil.

LUBRICATING GREASE FOR WHEEL BEARINGS

Wheel-bearing greases for motor vehicles were formerly different from those of the guns towed. But, today, the soda-soap type of N.L.G.I. No. 2 consistency grade[1] is specified by the Treasury TPS class 14 awards.[3] The Treasury Department specification calls for 280 Saybolt seconds minimum at 100 F, whereas the Quartermaster specification using the same TPS contracts uses only those with a minimum of 120 seconds viscosity at 210 F. There seems to be no reason why a high-temperature soda-soap wheel-bearing grease made waterproof, such as specified by the Bureau of Aeronautics, Navy Department, and of N.L.G.I.[1] No. 2 consistency, should not be successfully used for wheel bearings of vehicles, guns, and airplanes, as well as pressure fittings and roller bearings of vehicles, tanks, and airplane control bearings. Such an over-all use in summer months would greatly reduce confusion. However, the War

[2] N.B.S. 431 Pamphlet entitled "Lubrication Oil General Information—Requirements and Methods of Test," Bureau of Ships, U. S. Navy, shows the following tabulation

Navy symbol (S.A.E.)	Viscosity, S.U.V. at 210 F	Viscosity index, A.S.T.M. min
1042 (10)	40–44	100
1065 (30)	62–68	100
3065 (30)	60–70	75
1100 (50)	93–103	95
1120 (60)	115–125	95

[3] The Procurement Division of Treasury Department put out multiple awards under TPS contract numbers to various companies so bidding regardless of price or quality; only a minimum is specified. General Schedule of Supplies—Lubricating and Other Oils and Greases (Class 14) for the period January 1, to December 31, 1941, covers the present period.

Department Committee on Fuels and Lubricants has set up the wheel-bearing grease requirements on vehicles and guns to one grade. The wheel-gearing manufacturers differ as to the viscosity of oil to be used in a wheel-bearing grease, even though field experience tends toward high viscosities such as S.A.E. 60 or 70 grades. The truck and car manufacturers recommend three grades where the War Department specifies one on the same makes and models of vehicles. The only available cleansing fluid for parts and wheel bearings in the field is gasoline.

WATERPROOF LUBRICATING GREASE

With modern new equipment there is no need of carrying a waterproof grease for vehicles or tractors, yet such greases are being delivered to the War Department today. This water pump grease not only adds to the number of products to be carried in the field but often this hard product is used in grease fittings and cups on outboard water pumps where the chassis grade is needed for proper feeding or lubrication. Surely such practice should be discontinued in future design. The War Department Committee had to set up waterproof grease No. 4 (N.L.G.I.)[1] grade. Treasury TPS class 14 contracts[3] cover this award under water-pump lubricant.

HYDRAULIC RECOIL AND MISCELLANEOUS OILS

Where formerly there were two hydraulic-brake-fluid products, the War Department committee has reduced these to one. The recoil oils are now two instead of eight. Where three specifications covered lubricants for small arms, S.A.E. 10 (Navy symbol 1042) is to be used. As stated before, railroad-car oils are reduced from two grades to one. Rust preventives are also undergoing a radical change of standardization, as are shock-absorber fluids and vacuum-cylinder oils.

MARINE-ENGINE LUBRICATING OIL

Since the greatly increased marine program calls for such a large number of power units, the steam engine is now being produced in large numbers for marine cargo carriers. This brings back the use for marine-engine oils (Navy symbol 4065). Since rape seed oil used for compounding is imported and scarce, other fixed oil substitutes had to be worked out. For steam cylinders, either Navy symbol 5190 or 6135 is recommended except where exhaust-steam condensate is used for ice making; then Navy symbol 5150 oil is used.

GENERAL

There have been special problems in cutting stud bolts for aircraft engines from stainless steel where only carbon tetrachloride gives the smoothness of threads desired. The evaporation rate of such a fluid is high and the fumes are toxic. In shell-loading plants, a lubricating oil has to be mixed with graphite of a certain grade, yet no tests have shown that graphite reduces static electricity, if there is such a hazard.

TRANSPORTATION AND PACKAGES

The 750-gal tank truck with demountable tank to fit a $2^1/_2$-ton 6×6 ft cargo truck is being developed so that the tank can be transferred from a disabled truck to a serviceable truck. At railheads or from tank trucks ten or more miles from the front, 5-gal Q.M.C. containers are used for fuel. The engine oils are in 5-gal cans, whereas the chassis and wheel-bearing greases are in 25-lb containers. The 25-lb can of water-pump lubricant is too large and only the 5-lb can is needed until water pumps are redesigned to use the chassis grease. For universal-gear oil, the light-iron half barrel is about as popular as the light-iron quarter barrel.

OBSERVATIONS OF THIRD ARMY MANEUVERS IN LOUISIANA

The blackout servicing of gasoline, lubricating oils, and greases to vehicles after dark presents a problem of identification. It is easy enough to put one's finger in gasoline and tell it from lubricating oil but to tell engine oil from gear oil by such methods is out of the question in utter darkness. As long as the oils are in the original containers as now shipped by the manufacturers, engine oil can be distinguished by package shape, but class 2 gear oil is hard to tell from class 3 and some cannot distinguish chassis grease from water-pump or wheel-bearing greases where these are in 25-lb pails.

TABLE 1 U. S. ARMY STANDARD NOMENCLATURE FOR AUTOMOTIVE LUBRICANTS AND SPECIALTIES

Product	Guide-chart key	June 18, 1941. Procurement specification
Engine oil S.A.E. 10	EO	Navy symbol 1042*
Engine oil S.A.E. 30	EO	Navy symbol 1065 or 3065*
Engine oil S.A.E. 50	EO	Navy symbol 1100*
Diesel-engine oil S.A.E. 10***	DO	Approval list and specification
Diesel-engine oil S.A.E. 30***	DO	Approval list and specification
Diesel-engine oil S.A.E. 50****	DO	Navy symbol 1100*
Gear oil S.A.E. 80	GO	Navy symbol ——
Gear oil S.A.E. 90	GO	Navy symbol 1100 or 3100
Gear oil S.A.E. 140	GO	Navy symbol 1120 or 3120
Universal gear oil S.A.E. 80EP	EP	Treasury TPS. ** Class 14VV-L-76 Class 1
Universal gear oil S.A.E. 90EP	EP	Treasury TPS. ** Class 14VV-L-76 Class 2
Chassis grease No. 0	CG	Treas. TPS. ** Class 14—chassis general-purpose lubricant, winter grade
Chassis grease No. 1	CG	Treas. TPS. ** Class 14—chassis general-purpose lubricant, summer grade
Wheel-bearing grease. No. 2	WB	Treas. TPS. ** Class 14—wheel-bearing lubricant, regular grade
Waterproof grease, No. 4	WP	Treas. TPS. ** Class 14—water-pump lub.
Hydraulic-brake fluid	HB	Approval list—pending specification
Shock-absorber fluid, light	SA	Approval list—pending specification
Shock-absorber fluid, heavy	SA	Approval list—pending specification
Vacuum-cylinder oil	VO	Approval list—pending specification

* Product names and procurement specifications approved by War Department Committee on Liquid Fuels and Lubricants on May 27, 1941.

** Treasury Procurement Division General Schedule of Supplies.

*** Special oils with additives approved by Allis-Chalmers, Caterpillar, Cletrac.

**** Used only for Guiberson Diesel. May be compounded at later date.

Oil-filter change recommendations of 2500 to 5000 miles are too high as convoys and maneuvers over dusty roads show 500 miles to be needed as the change period in many instances in dry, dusty, stump areas. Dust is often found inside oil pans. One or two types of oil filters are recommended by the motor-transport officers instead of the six or more now needed at each light-maintenance hideout.

The air cleaners of motorcycles generally need cleaning every day while operating in dusty country. Either a larger or a more effective cleaner is needed to avoid added man-hours.

Of all the lubrication failures, that caused by ineffective oil seals of transfer cases and front differentials was most pronounced at the Third Army maneuvers so far at Louisiana, where approximately 30,000 vehicles are taking part in the war games. In the first place new seals are dry and need soaking in oil. The front differential housing vent gets plugged

(*Continued on page 800*)

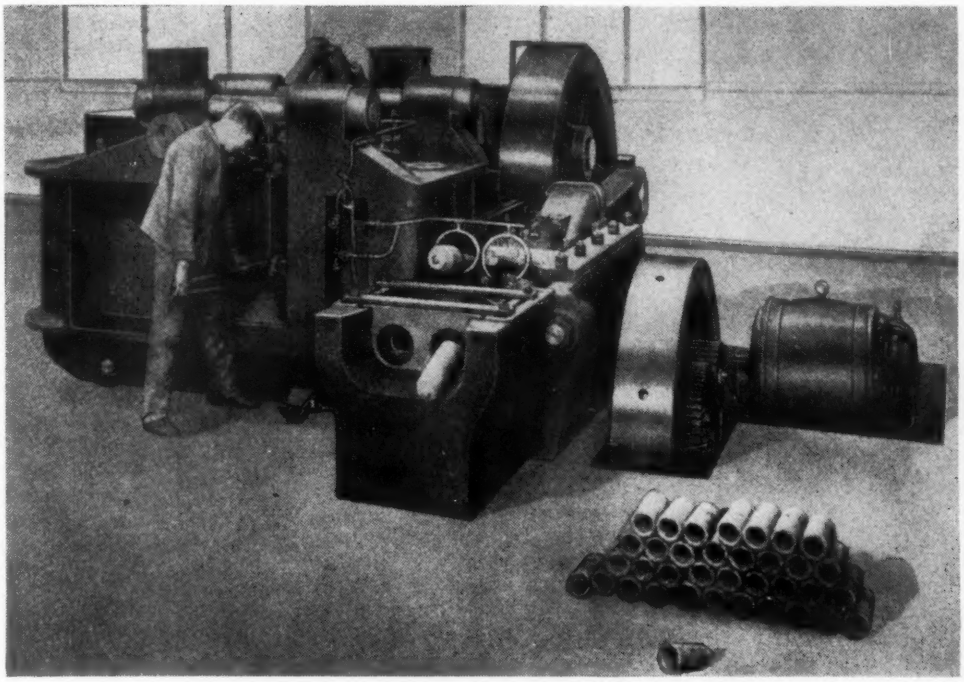

FIG. 1 BALDWIN-OMES SHELL-FORMING MILL

MODERN SHELL FORGING *and* TORPEDO-BODY PRODUCTION

By ALBERT B. CUDEBEC and ERWIN LOEWY

LOEWY ENGINEERING CO., LTD., LONDON, ENGLAND

NEW methods of warfare have tremendously increased the demand for smaller-caliber shells (5 in. diameter and under) for use in fast-moving armored divisions, for antiaircraft guns, and for small guns mounted in long-range bombing planes. An abnormal demand, equaling in urgency that of artillery ammunition, has also occurred in the torpedo field.

The subject of this paper, obviously, is much too broad to attempt to discuss this entire field, and comments will therefore be confined to the methods of producing in American shops clean-cavity forgings below 6 in. diameter. The paper will also discuss one new and interesting plant now operating in Great Britain which is providing forgings for torpedo bodies, large-caliber shell forgings, and other examples of seamless hollow bodies.

Although America is now adopting the newer European methods in shell forging, the majority of American production, particularly in large diameters, is still following the older conventional methods which are not materially different, except in detail, from those used at the close of the first World War.

Those members who are interested in the whole range of shell manufacture will find that American technical literature covering the subject is rich, and particular reference is made to the series of recently published papers by Arthur F. Macconochie of the University of Virginia. These papers appear to be among the most useful and complete contributions to the subject as yet published.

Three examples of new and improved processes which have appeared in America for producing the smaller sizes and one special process now used in England will be discussed.

The production of shell forging falls into three general classifications

1 The piercing and drawing method
2 The upsetter method (with several modifications)
3 The piercing and rolling, or "Witter" method.

BALDWIN-OMES PROCESS

One of the more recent and successful methods of shell forging is the Baldwin-Omes process, which is performed upon a mechanical press, and was first developed in Germany. This patented method has now been successfully introduced to America by the Baldwin-Southwark Company. (See Fig. 1.)

This process starts with a square billet. The split die arrangement is circular when closed and the billet is squeezed at its beveled corners and held symmetrical with the closing of the die. There is a bushing of high-grade steel in the die, which guides the mandrel, and since only linear motion takes place,

Contributed by the Metals Engineering Division and presented at the Fall Meeting, Louisville, Ky., Oct. 12-15, 1941, of The American Society of Mechanical Engineers.

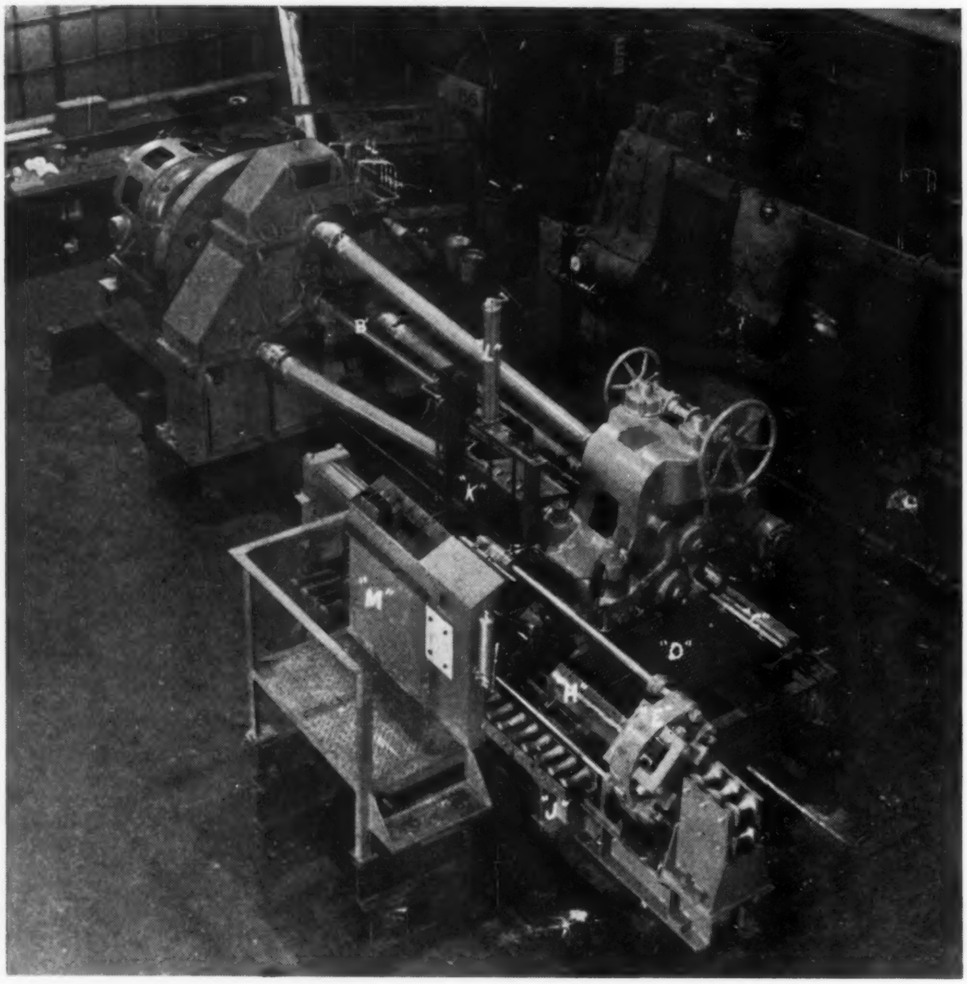

FIG. 2 WITTER SHELL-FORGING MILL

production rate with two drawing mandrels.

The following is a brief résumé of a plant suitable for producing shell forgings up to about 4 in. diameter.

The process starts with square billets having flat corners, cut into appropriate lengths, heated in a pusher-type furnace, and brought to the center of the press for piercing by a rapidly moving conveyer.

Attention is called to the fact that the piercing mandrel, mounted in vertical position, remains stationary upon a fixed crosshead. The piercing process is performed by forcing the die assembly over the close-fitting flat corners of the billet, under 400 tons pressure, and the billet is pierced and expanded out to the wall of the die as it pushes over the mandrel head.

The pierced blank is then quickly cleared by automatic strippers and ejector arrangement and shifted either right or left by means of a tongue, to the drawing presses, one mounted upon each side of the piercing assembly.

The drawing presses, operating at 200 tons pressure, are also designed with fixed mandrels, and operate at such a speed that one piercing device will supply enough material for the two drawing presses.

This type of combined piercing and drawing press, as in the Baldwin-Omes type, requires a minimum amount of handling of workpieces. The machines can be mounted close together in batteries so that one accumulator may simultaneously furnish high-pressure water to several presses.

the piercing mandrel enters the square-section billet in the center, thus producing a perfect, concentric shell. Rejections are reported as being remarkably low.

The smaller sizes of these presses (3-in. to 5-in. shells) are designed with a piercing and drawing machine in one unit, while the larger sizes (for 5-in. to 7-in. shells) have a separate drawing machine.

The production records achieved by this process upon machines now in operation in the United States exceed their rating capacity.

Regular operating records show that 90-mm shells are regularly produced at the rate of 160 shells per hour, and shells of 105 mm are being turned out at the rate of 120 per hour per machine.

All forgings are completed in one heat and are close to final dimensions, hence the savings in machining costs are important.

LOEWY HYDRAULIC-PRESS PROCESS

Another successful method has recently been developed by the Loewy Engineering Co., Ltd.

This method will produce both large and small calibers, but has been used more widely upon 3-in. and 4-in. shells.

The process consists of a new development of the conventional method. A hydraulic press, which combines the piercing element, and two drawing presses are mounted together in one vertical-type assembly, and the power plant is an air-hydraulic accumulator of air and water bottles yielding high

THE WITTER PROCESS

The Witter process is a development arising from the Assel cross-roll and elongator mill, which was first designed and used by the Timken Roller Bearing Company for tube manufacture, in conjunction with a piercing mill, in 1935.

By the addition of mandrel handling and sizing equipment, shell forgings were successfully produced in January, 1941, upon equipment which was developed by the Salem Engineering Company.

A brief description of the operation of the Witter process follows: Billet steel is properly upset, forged, or pressed to form the pierced blank. This blank is conveyed to a loading station of the finishing mill where it enters the breakdown pass of the humped rolls with a smoothly machined mandrel inserted in the cavity of the pierced blank. The mandrel is kept bottomed in the blank by pressure from a pushing cylinder during the breakdown, elongating, and cross-rolling operations. On elongating, the metal wraps tightly on the mandrel as it passes through the humped rolls, thus producing a smooth and uniform cavity in the shell forging. After leaving the rolls, the forging

is sized with mandrel still inserted and then the mandrel is automatically stripped, leaving the shell forging completed and ready for machining operations elsewhere. Ten or more mandrels are continuously in use in the automatic cycle and are properly cooled, thus assuring a uniform production of shell forgings.

It was found that the pierced blanks could be produced by utilizing existing steam drop hammers, thereby saving the time and expense of developing new equipment. These pierced blanks are then finished upon a Witter mill.

Regular production of 75-mm forgings at the rate of 280 per hour are reported, and hourly runs above 300 forgings have been realized. Regular production of 1600 forgings per 8-hour shift of 105-mm shells and single hour runs of 287 forgings are reported.

The Salem Engineering Company believes that one of the outstanding features of the Witter process is to be found in substantial savings of material by producing 75-mm shells from a steel billet weighing approximately 16 lb as compared to a 20-lb billet required by some other methods. This saving is also reflected in transportation, machining, and tool costs.

An examination of production data appears to show that all of these methods are giving satisfactory results.

Comparison of costs and volume of output are difficult. To arrive at unbiased figures, it would be necessary to have cost figures upon identical sizes and conditions. It is probably correct to say that not only the government officials but also the manufacturers are more interested just now in volume of production (combined with good quality) than they are in unit costs.

We now turn to the discussion of a modern method of hollow forgings, recently adopted in Great Britain, the increased production of which has brought about the application of the conventional draw bench upon a scale heretofore quite unknown.

TORPEDO FORGING

When Great Britain, toward the end of those regrettable "appeasement days," suddenly found herself face to face with realities, she realized that all, or nearly all, of her supply of large, hollow, seamless bodies came from Germany. She could not produce them at home in quantities anywhere near to meet the government's crying needs.

The installation of a monster draw-bench plant was therefore decided upon to be installed in England's latest and most modern steel mill, The Chesterfield Tube Company, and the company with which the authors are associated was commissioned to design and supply this equipment. (See Figs. 3 and 4.)

It was generally supposed at that time that castings and forgings of the required huge sizes and weights could only be produced in German mills and it is understood that all of the German suppliers of the essential castings and forgings were notified by the German government to decline to quote upon this job.

The detailed story of the means taken to overcome these difficulties and obtain these forgings and castings would be interesting to American steel foundries and forging suppliers but would not be fitting in a technical discussion.

The complete installation required about 14 months before it was put into operation and the following is a list of the main equipment together with dimensions, characteristics, and weights:

1 The main horizontal-tube draw bench, working pressure 3150 psi, weighs 583 tons.

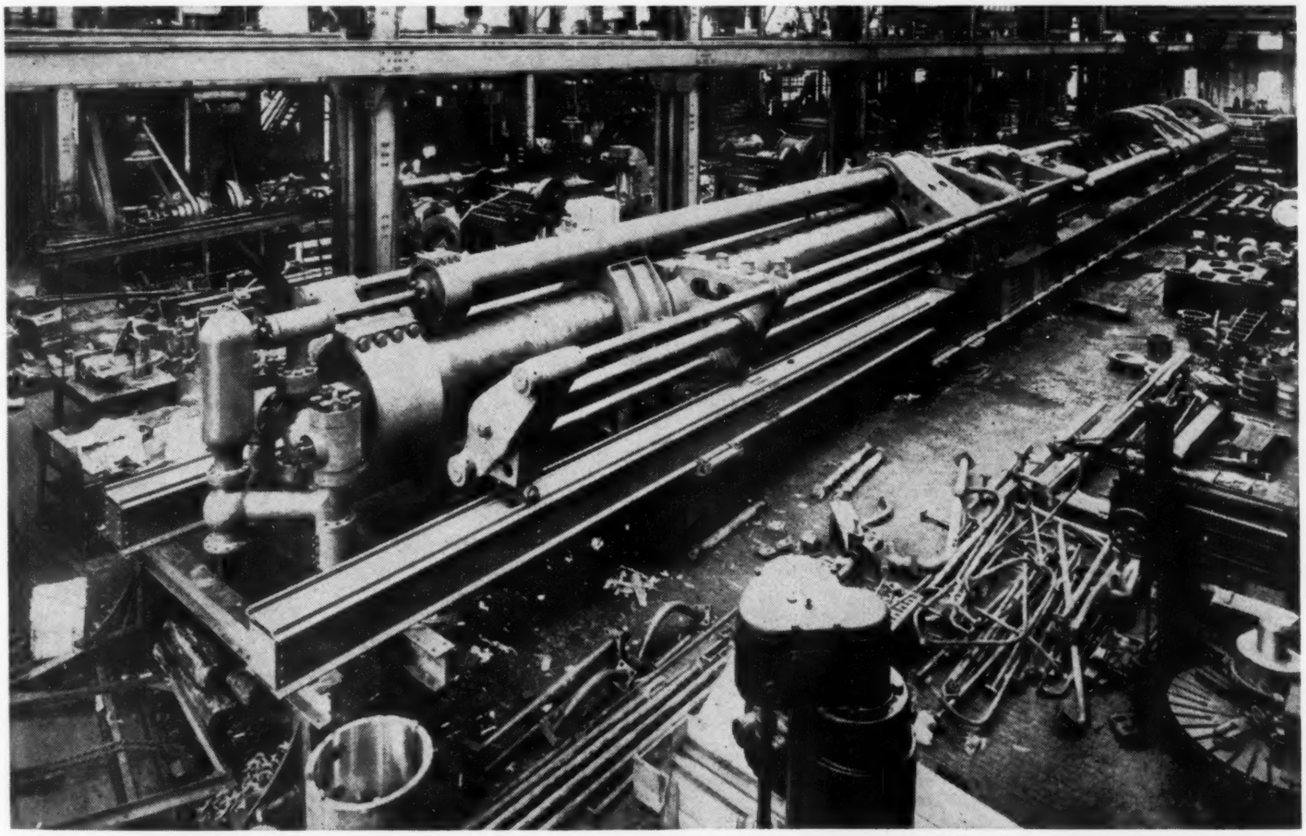

FIG. 3 WORLD'S LARGEST DRAW BENCH FOR PRODUCTION OF HEAVY SHELLS, TORPEDO BODIES, AND OTHER HOLLOW VESSELS FOR BRITISH NATIONAL DEFENSE

2 The 5000-ton billet piercing press, working pressure 3150 psi, weighs 825 tons.

3 The 3000-gal air-hydraulic accumulator plant (one of the world's largest at that time) weighs 363 tons.

4 The billet heating furnace has a heat range up to 2375 F.

5 The billet soaking pit has a heat range up to 2375 F.

6 The recuperative tube reheating furnace.

7 Three triplex pumps, 500 hp each, weigh 66 tons.

8 Over-all length of main draw bench, 154 ft.

9 Maximum weight of steel billet, 20 tons.

10 Maximum outside diameter of finished drawn hollow body, 54 in.

11 Maximum wall thickness of hollow body, 6 in.

12 Length of stroke, 40 ft.

13 Maximum length of finished hollow body (or tube), 35 ft.

14 The total weight (including piping and auxiliaries) is approximately 2110 tons.

The plant is now operating continuously under forced pressure in producing the following materials: Large shell forgings, torpedo-body forgings, submarine air vessels, accumulator bottles, superheater headers, mud drums, large high-pressure steam piping, water and steam drums, and Diesel-engine starting bottles.

BRIEF OUTLINE OF MANUFACTURING PROCEDURE

The billets are preheated in a bogie-type furnace and then brought for soaking into a pit furnace. It is also possible to heat the billets finally in the bogie-type furnace, if desired. By means of a crane with rigidly guided lifting tongs, the heated billets are brought into the matrix of the piercing press standing outside of the latter. After shifting this matrix into the center of the press, the billets are pierced with a punch, thus producing a hollow body. After having shifted the matrix sideways, the pierced billets are ejected and then brought by means of the crane into the horizontal draw bench which pushes the hollow bodies in the same heat through several dies, so lengthening the body and reducing its wall thickness. Dependent on the final size of the drawn tube, one or two strokes with the draw bench might be necessary with the same heat and in some cases where the final wall thickness requires more drawing operations, the tubes are reheated in a special reheating furnace of the roller type. If hollow bodies should be manufactured having both ends closed in, a special bottling press will be necessary together with a reheating furnace for heating the bottle ends.

The installation of this equipment, as already mentioned, was primarily intended for the production of seamless drawn high-pressure flasks for use in air-hydraulic accumulators, and for other uses where high-pressure water, air, or gases were required. It was found, however, that torpedo flasks of around 22 in. finished diameter could be produced quicker and cheaper than by the older conventional forging methods, and it is reported there is a large production of torpedo bodies now being made on this draw bench for the British Government.

One of the main reasons why this method has proved so successful and economical is because the outside-diameter dimensions can be drawn closely to finished sizes, thus the large amount of machining which is required by the conventional forging process is greatly reduced.

Owing to the unusually large dimensions of the press, it is probably not economical to use it for producing hollow bodies or tubes below 12 in. diameter. Below this size the bushings to fill in the immense die-holder spaces would present some awkward problems.

FIG. 4 ANOTHER VIEW OF DRAW BENCH OF FIG. 3, SHOWING DETAIL OF DIE HOLDER

PLASTICS APPLIED *to* AIRPLANE STRUCTURES

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DURING the last few years engineers and production men in the aircraft industry have been giving ever-increasing attention to the possibilities of extending the use of plastics into the basic airplane structure. An attempt to provide a substitute material for the presently used metals is only one of many reasons for this interest. Increased simplicity, wide availability of raw materials, weight reduction, and lower production costs are some of the possibilities promised by the use of plastics.

These possibilities can only be completely exploited through a carefully planned research and development program embracing not only an investigation and research in the field of plastics but a comprehensive study of their possible applications, design advantages, and limitations, and the production processes and problems involved in handling them. Recognizing this, the author's company has undertaken such a program after making a thorough study of the technical and economic problems involved. Since the inception of this program materials have been developed, in cooperation with prominent plastics manufacturers, which have mechanical and physical properties satisfactory for structural applications. Further improvements are now being made and production procedures and processes as well as designs are being devised with a view to the most efficient application of plastic materials to the requirements peculiar to the aircraft industry.

This discussion will be limited to application of plastics to the basic structure and other portions of the airplane which are now fabricated from sheet metal.

APPLICATIONS

Before entering into a discussion of plastic materials and their relationship to airplane design and manufacture, it might be well to review briefly the possible applications of these materials and to consider the reasons which have thus far prevented their extensive use in airplanes. The applications may be listed as follows

A Primary structures

1 Spars, complete with chords and stiffeners
2 Skin, complete with stiffening elements
3 Ribs, frames, and formers
4 Seats and flooring
5 Control surface covering
6 Propeller cuffs and spinners

B Secondary structures

1 Leading-edge assemblies
2 Miscellaneous brackets, braces, etc.
3 Wing tips
4 Ducting and cowling
5 Fuel tanks (leakproof)

C Nonstructural

1 Fairing
2 Cabinets, etc.
3 Paneling and trim
4 Access doors
5 Junction boxes, conduit, etc.

This listing does not include uses of thermoplastics for windows, windshields, knobs, and the like.

These items represent about 15 per cent of the design gross weight of an airplane or about 22 per cent of the weight empty, that is, the manufacturing weight. They represent about 60 per cent of the fabricating cost to an aircraft manufacturer, engines, propellers, instruments, and miscellaneous equipment being purchased outside. Thus, in a small, 6500-lb gross-weight, single-engine pursuit airplane there could be as much as 1000 lb of plastic material. Obviously, production of a plastic airplane in any quantity will require several thousand tons of resin and filler material.

The only present uses of plastics in airplane structures is in trim tabs and pulleys, neither of which may be considered primary structural parts, that is, parts whose failure could result in disintegration of the whole structure. Neither of these items are subjected to extreme loading conditions and both may be made from the same raw materials as any high-grade commercial laminated phenolic.

Low strength and even more particularly low elastic moduli are the principal reasons why plastics have not been used more extensively.

Besides the lack of satisfactory mechanical properties, several other factors have discouraged wider use of plastics. For one thing there has been no appreciable amount of cooperation or coordination of effort between aircraft and plastic manufacturers. This has probably been due to a failure of these two groups to understand one another's problems and to a lack of a common technical footing, as the plastics industry is concerned chiefly with chemical problems and the aircraft industry with mechanical problems.

Another factor has been the production quantities involved. The plastics industry in general operates on a mass-production basis and production methods, designs, and procedures are set up for mass production. On the other hand the aircraft industry operates on a quantity-production basis and 5000 units of any one design is still considered a very large quantity. This means that the mass-production processes of the plastic industry are in general impractical for quantity production as in aircraft.

Closely connected with the quantity of units to be produced is the size and number of different parts which go to make up these units. Aircraft structural moldings must be large and panels 12 to 15 ft long and 3 to 5 ft wide would not be exceptional in plastic design. While one particular part or group of parts may be used at several places on one design, there are still bound to be relatively large numbers of different parts requiring

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an equal number of different molding dies to fabricate them.

It is clear then that the applications of plastics to airplane structures not only depends upon the development of materials having suitable mechanical characteristics but also upon the development of designs and processes which will permit their adaptation to the peculiar requirements of the airplane industry.

To date no true plastic airplanes have been produced. It is understood that seats and fairings are being made from plastic materials abroad. Some Russian aircraft used in the Spanish Civil War had laminated phenolic wing covering which was not stressed, however.

It should not be expected that plastics can or ever will completely eliminate metals in the basic structure of the airplane. Sheet metal, aluminum, and steel must be used for such items as exhaust manifolds, exhaust shrouds, some of the ducting, straps, baffles, and similar parts where such properties as high heat resistance or ductility are required. Plastics have their field in airplane manufacturing and offer certain definite advantages over sheet metal in many applications but they cannot be considered a cure-all for manufacturing or design difficulties. All industries are now reaching a point where special materials are required to meet specific needs and the list of different materials employed in any one industry is expanding rather than contracting. This is especially true in aircraft where high standards of strength and durability must be met while at the same time the completed product must have the least possible weight.

MATERIAL

Before outlining the general requirements for a satisfactory structural plastic, the term "plastic" should be defined. The name generally implies a synthetic material resulting from chemical reactions which form complex hydrocarbons. The plastic may be adulterated or "filled" with some ground or fibrous material or it may be "pure," that is, unfilled. In any case it will respond chemically to the application of heat and pressure and alter its form and composition so as to take the shape desired in forms or dies.

In contrast to the implication of the term "plastic" we have the wood-base materials. There has been a tendency on the part of some manufacturers to confuse plastics with plywood and laminated wood because recently manufactured materials of this type have been plastic-bonded. Actually, the plastic-bonded wood veneers are no more a plastic than the older casein-bonded wood was a "casein." Wood employed in any form where it maintains its original identity as wood still has local defects and a tendency to split and crack. This applies even when the wood is fully impregnated and compressed. However, if the wood loses ts identity by pulping or being floured and is then incorporated in a plastic, the resulting material can logically be called a plastic.

Materials of the low-density class may be differentiated from one another and subdivided as follows

A Plastic

1 Thermosetting types—infusible after initial setting
  (*a*) Filled
  (*b*) Unfilled
2 Thermoplastic types—resoftened by heat
  (*a*) Filled
  (*b*) Unfilled

B Wood (all species)

1 Planks and strips
2 Plywood and laminated veneers bonded by plastic, animal, or vegetable glue
3 Impregnated and compressed types

A study of the fundamentals of structural analysis shows very definitely that the lower the density of the material the more satisfactorily it lends itself to the stressed-skin type of design used in airplane construction. The lower the material density the thicker the skin may be, thereby reducing both the unit loadings and the tendency of the loaded skin to fail because of instability. This advantage of low-weight materials may lead either to lighter weight structures or simpler structures, or a combination of the two. On this basis alone, and not considering any possible production advantages or the matter of material availability, plastics offer considerable possibilities for simplification and cost reduction.

Wood, except in the impregnated and laminated form, has a lower density than any of the plastics and therefore has an advantage in this respect. However, this advantage is nullified by its moisture-absorption characteristics, low bearing strength, "grain" tendencies even in the laminated condition, and the necessity of choosing straight-grained, defect-free material of certain species which represent only a small percentage of the total available wood supply. These same disadvantages apply, in part, to the impregnated woods.

Plastics, and more specifically the filled materials, do not have these disadvantages, and furthermore a relatively wide variety of filling materials may be employed. Experience has shown that the filler is almost entirely responsible for the strength and moduli of the plastic. Naturally some fillers give better mechanical properties than others but when properly handled all will provide good characteristics. Thus, cotton, hemp, wood fibers, ramie, and other fibers may be used for filler, offering an outlet for agricultural products of all types and grades. This may have a far-reaching influence upon the ideal of achieving a closer tie-in between agriculture and industry.

Practical considerations demand that the properties of a structural plastic conform to the following general requirements

1 Mechanical properties satisfactory from a structural standpoint.
2 General chemical inertness.
3 No loss in properties throughout the range of atmospheric temperatures normally encountered and preferably resistant to temperatures up to 300 F.
4 Low moisture absorption.
5 Ease of handling and molding in very large units with good resulting uniformity.

Neither the thermoplastic nor thermosetting materials have anywhere near satisfactory mechanical properties in the unfilled condition. Fig. 1 shows typical stress-strain curves for several unfilled plastics and also the stress-strain curve for a filled plastic suitable for structural use. The increase in strength and modulus is apparent.

The actual choice of the filler material depends not only upon the mechanical properties desired but upon the availability of the filler, economic considerations, and the ease with which it can be molded when incorporated in the resin. The fibers should have the highest possible strength-weight ratio, preferably higher than that of aluminum alloy, in order to overcome the weight loss caused by the presence of the resin which contributes little strength to the finished molding. Fortunately, most usable fibers satisfy this requirement. On the other hand, the use of any kind of metal mesh is precluded because magnesium, aluminum, and steel alloys all have substantially the same strength-weight ratio and no other abundant metals exceed their ratios; also the use of a high-density filler would substantially increase the density of the final product, thereby destroying the advantage of low density.

From a standpoint of chemical inertness the thermosetting plastics, phenol and urea formaldehyde, are more satisfactory than the thermoplastics. Furthermore, the thermosetting materials will not resoften under heat after the initial curing—they have generally better resistance to heat and moisture. Thus they satisfy the requirements of chemical inertness, maintenance of properties under varying atmospheric conditions, and low moisture absorption.

The ease with which the material may be molded depends largely upon the amount of attention given to this during the development of the material. While the present commercial plastics are well suited to the requirements of the plastics industry which is manufacturing relatively small parts on a mass-production basis, the materials have a number of disadvantages from the aircraft-production standpoint. These disadvantages are

1 The high molding pressures, in the range of 1000 to 3000 psi, require too great a press capacity for the molding of really large parts of the sizes and shapes required.

2 The cost of machining and finishing dies to withstand the high molding pressures is too great for the quantities of parts involved.

3 Experimental work requires almost the same tooling expenditures as production work.

4 Since the nature of the moldings prohibits the use of multiple-opening presses, the curing cycle is too long for truly high-speed production.

5 The method of applying heat to the dies by means of integral steam coils is expensive and inflexible.

These disadvantages have been given due consideration during experimental work to the end that the materials developed not only satisfy the technical requirements but the production demands as well. The necessary molding pressures have been drastically reduced and new diemaking methods have been evolved, thus eliminating expensive machining and polishing operations to a large extent. It also appears that semipermanent molds may be made which will be entirely adequate for experimental work. Means of reducing the curing cycle time and eliminating some of the expenses involved with present methods of heating the dies are also under investigation.

The following minimum mechanical properties are obtainable in a plastic material having a specific gravity of 1.3 or a weight of slightly less than 47 per cent that of aluminum:

Ultimate tensile strength, 20,000 psi
Ultimate compressive strength, 19,000 psi
Flexure strength, 21,000 psi
Elastic modulus, 1,800,000 psi
Shear strength, 12,000 psi
Bearing strength, 20,000 psi
Fatigue limit, of static strength, 35 per cent

These values are for a homogeneous material, that is, one which does not have grain tendencies and shows approximately uniform strength in all directions. Commercial materials usually do not exceed 14,000 psi in strength or have a modulus greater than 1,200,000 psi. Besides, they usually exhibit distinct grain tendencies. Without doubt further development will result in increasing the tensile strength and compressive strength to 25,000 psi, with proportionate increases in the other properties.

The material is not affected by oil or gasoline and is noninflammable.

MANUFACTURING REQUIREMENTS

Certain manufacturing requirements must be met if truly efficient production of plastic airplane subassemblies is to be attained. These requirements are dictated by two considerations

1 Equipment and facilities presently employed and the personnel available for operating the equipment.

2 Properties and characteristics of material being worked.

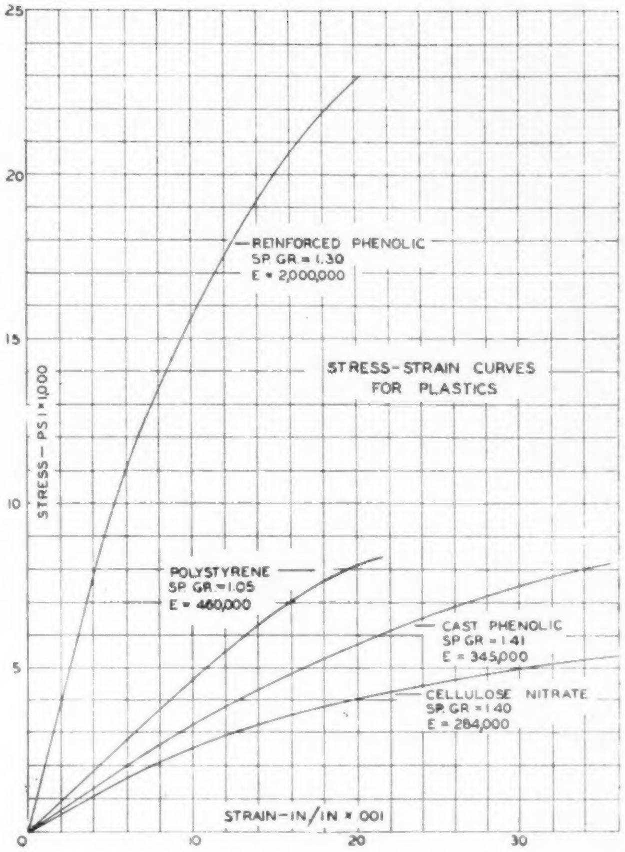

FIG. 1 STRESS-STRAIN CURVES FOR PLASTICS

Every reasonable effort should be made to avoid excessive alteration or scrapping of existing equipment in contemplating the change from sheet-metal to plastic construction. It might logically be expected that a large amount of alteration or scrapping of equipment would be necessary. However, a study of the problem indicates that a large proportion of the present equipment may still be used. This is fortunate because it means that the effect on personnel will not be very great and that education of employees in the operation of new types of equipment will be unnecessary.

While it is essential that the processing methods employed with plastics be so devised and arranged that the maximum amount of manufacturing equipment on hand may be utilized, this should not be carried to an extreme where the production advantages to be gained from plastics will be offset.

The raw plastic should be easy to ship, store, and handle. Its form, as supplied to the manufacturer, should be such as to naturally provide clean processing operations which in turn will be reflected in fast efficient production.

Molding pressures required should be relatively low, that is, 250 psi or less. This will result in lower press capacities and permit the use of cheaper dies and simpler more economical diemaking methods.

Molding operations and handling of the molding should be so conceived as to permit the use of the standard metal-forming presses now employed.

Molding temperatures should be kept as high as practical in

order to reduce the curing cycle. The plastics used should be fast-curing. The method of heating the plastic should be as simple as possible.

Dies should be economical to manufacture and inexpensive to replace. The materials employed and the diemaking technique should approximate those now used in the fabrication of dies for sheet-metal production.

Methods of handling dies and loading and unloading the presses should be similar to those used in pressing sheet metal.

The design of parts for molding should be such that they may permit full use of the production techniques finally developed. Sections of structural components should be simple and easily adaptable to molding methods.

The separate molded subassemblies which comprise the complete airplane should be rigid enough in themselves and manufactured with sufficient accuracy and completeness so that they may be fitted to one another and bolted, bonded, or riveted together with little or no jigging required. The dies on which the parts are molded should replace the jigs and dies normally used. Thus the cost of molding dies is largely defrayed by the elimination of both the jigs and dies now employed with sheet-metal construction. It is conceivable that floor space will be saved by the elimination of jigs if suitable die storage facilities are available.

MANUFACTURING PROCEDURE

The following handling methods and routing of parts through the factory are suggested by the requirements previously outlined.

The raw material consists of the filler material which is impregnated with a thermosetting plastic. The most suitable plastic found to date is phenol formaldehyde. As supplied by the raw-material manufacturer, the resin is in the "B" stage, that is, it is dry and can be easily handled but as yet it is unpolymerized. Polymerization occurs when the heat and molding pressure are applied to transform the raw material into an insoluble, infusible form.

It should be pointed out here that the same relationship between the plastic manufacturer and the aircraft manufacturer should exist as now exists between the metal manufacturers and the aircraft industry. That is, the plastic mnufacturers would supply raw material, in convenient form, which would be molded in the aircraft factory. Thus the material would be controlled at its source and the design and details controlled by the fabricator.

The raw stock may be supplied in one of two forms (*a*) as rolls of impregnated material furnished in two standard thicknesses, or (*b*) in a sheet form of any thickness desired. The material can be designated as roll or sheet stock depending upon the condition as furnished.

The roll stock might be graded in two thicknesses, one to give a finished molding 0.020 in. thick for one layer of raw stock and another to give a finished molding 0.010 in. thick per layer. To obtain the required gage in a finished molding the desired number of laminations would be built up and gages would thus vary in increments of 0.010 in. Differentiation between the two sizes of roll stock might be achieved by the use of dye in the impregnating resin. With gage increments of 0.010 in. this would correspond to increments of 0.0045 in. in aluminum alloy on a weight basis. By "dropping off" laminations, taper could be achieved in the cross section of the finished molding.

In the thicker moldings the sheet stock might be used starting at 0.090 in.

Suitable storage facilities, providing humidity and temperature control, must be supplied for incoming stock since resins cure slowly over a relatively long period of time. The molding operation is merely a means to accelerate this curing. Storage facilities for formed sections such as angles and channels need not be provided as these can be molded and used as required. Furthermore, it is unlikely that as large a variety of sections will be used as now employed with aluminum so that finished-parts storage space may be reduced. It is probable that it will be found desirable to store the raw stock below ground level with a suitable elevator system to convey it to critical points in the factory.

Raw stock may be first sheared to rough size or it may be sent to the router or shapers. It is necessary to produce molding blanks for charging the dies. The thinner roll stock may be cut on single blanking dies consisting of sharpened strip steel inserted edgewise in wood panels. Bolt holes and locating pinholes may be drilled during routing or separately located after blanking or shaping.

The raw blanks, as they come from the router, shaper, or blanking die, may be stacked beside the molding presses ready for immediate use. The production-control system should prevent an excess of molding blanks from being built up to eliminate the necessity for restoring the uncured stock.

After the molding operation the parts are trimmed as necessary and stored or sent directly to final assembly. The moldings are designed so as largely to eliminate the necessity for jigging the subassemblies for final attachment to one another.

Storage facilities, shears, routers, shapers, presses, and saws are all applicable to plastic work. An increase in press capacity is, of course, necessary. Press brakes, riveters, and drills are partly applicable. In some instances equipment can be rendered usable for molding by reworking.

It appears that most of the present sheet-metal equipment is applicable; a rough guess is that 60 per cent is usable figured on a cost basis.

In addition to the labor savings, certain fundamental cost reductions may be achieved. Among these are: (*a*) Saving in drill and small-tool breakage, by elimination of riveting; (*b*) saving in floor space brought about by elimination of considerable benchwork, jigs, paint booths, anodic treatment, and the like; (*c*) ultimate reduction in tool-design time through reduction in number of parts and substitution of dies (made from loft templates by standard foundry practices) for the more complicated assembly jigs now required. The increased investment in presses may be largely offset by the decreased investment in the large quantities of small tools such as drills, riveters, fastening devices, and the like, which are necessary to the normal sheet-metal construction.

SUMMARY

Although plastics are now being considered mainly as a substitute for metals, this factor in itself is not sufficient reason for devoting effort to their development. Were this the only argument for their adoption, it would be far better to expend the same effort toward increasing metal-producing facilities.

The future of plastics in airplane manufacture and especially their application to structural components depends almost entirely upon the amount of research and development effort expended to effect their usability and the ingenuity applied both in designing for and manufacturing with these materials. On the basis of technical considerations alone, which are not discussed in detail here, plastics can, and undoubtedly will, permit structural simplicity which will reflect itself in weight savings and reduced cost.

There is good reason to believe that tooling up for molding will ultimately prove faster and less expensive than tooling up for sheet-metal fabrication. Tooling and fabrication difficulties may all be solved by conventional practices.

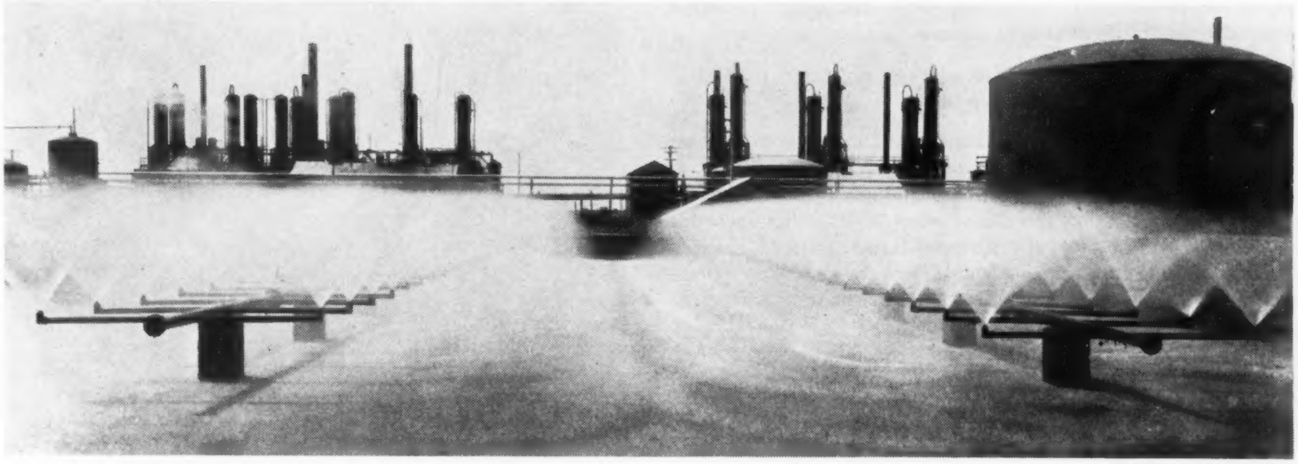

FIG. 1 TYPICAL SPRAY-POND WATER-COOLING SYSTEM

COOLING-TOWER PROGRESS

By L. T. MART

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ALL water-cooling equipment can be classified under three general headings: (1) Spray ponds, (2) atmospheric or natural-draft towers, usually of the deck type in larger applications, and (3) mechanical-draft towers. It is the intent of this paper to present elementary information concerning applications of these three groups and to discuss improvements and trends in the mechanical-draft field in particular. The last 25 years, which span the author's experience at such work, have seen many changes in the design and application of these products.

SPRAY PONDS

Between 1915 and 1920, the spray pond was the system generally in use for large water-cooling requirements. This apparatus called for large areas, a factor for consideration if space was costly or limited, and, except where earthen or natural ponds could be used, basins often proved expensive. The pumping heads ordinarily ranged between 25 and 30 ft. On the credit side, first cost was usually favorable by comparison with other equipment then offered, there was no power requirement for fans, and depreciation was extremely low on systems of proper materials, such as cast-iron pipe and fittings, together with bronze spray nozzles.

A well-designed spray pond of 10,000-gpm capacity requires a space about 130 × 140 ft. Additional capacity may be figured at about 4 sq ft per gal. Because of spray drift, ground close to such a pond is usually rendered unsuitable for use. A mechanical-draft tower for similar service, due to its higher thermal efficiency, now could equal the performance of the pond, circulating 8000 gpm in a space 60 × 90 ft, and the utility of surrounding areas would not be impaired.

The spray pond is limited in cooling performance. Furthermore, it is impractical to design one for severe cooling conditions, such as a close approach to the wet bulb with a relatively long cooling range. A well-designed spray pond will approach the wet bulb by an amount approximately equal to the cooling range, that is, if the pond must cool water 15 degrees, the cold water will be 15 degrees above the prevailing wet-bulb temperature, or if the cooling range is 25 degrees, the approach becomes 25 degrees. This rule-of-thumb method gives only a rough approximation, but it is not generally feasible to design the larger systems for much better performance, unless the water is sprayed a second time, thus doubling the space required, the pumping costs, and the investment. In such cases, when concrete basins or louver fences are required, the investment becomes excessive.

ATMOSPHERIC-DECK TOWERS

The atmospheric-deck-type tower has been very popular throughout the South and West, being considered quite satisfactory, wherever the location offers good exposure to the breeze, particularly in sections where prevailing breezes through the summer are from one general direction. However, while well suited to many industrial services in open or rural areas, they are not adapted to restricted locations where the breeze is limited.

Atmospheric-deck towers are usually designed with pumping heads of 30 to 40 ft. Drift-moisture nuisance is often considerable; chiefly for this reason such towers are not practical for locations on downtown-building roofs, nor adjacent to buildings or expensive mechanical equipment in industrial plants. They are generally unattractive if not definitely negative in appearance. Because they are usually long and high for their width, they must be securely anchored to prevent uplift or overturning during high winds. The fact that deck towers are commonly quite heavy, and expensive in relation to cooling performance, further accounts for their increasing rarity where roof installation is necessary, as in most air-conditioning and refrigeration work. Up to a certain size, first costs compare favorably with mechanical draft, although high pumping

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requirements and total dependence upon atmospheric caprice, especially wind, are offsetting factors.

NEW REQUIREMENTS CREATE DEMAND FOR SPECIALIZED COOLING EQUIPMENT

From 1915 to 1920, most larger water-cooling systems were furnished in connection with steam-condensing operations, and most power plants were located in the country where land was cheap enough to permit the use of spray ponds. Refrigeration and ice making constituted the second largest outlet for water-cooling equipment, using both deck towers and spray ponds, customarily on roofs. Other markets then were of minor importance.

However, since that time new markets have arisen, others have developed and, with this shift, requirements have become decidedly varied and exacting, necessitating refinements and specialized adaptations in water-cooling equipment. Today, the principal demand for large water-cooling systems is from the oil-refining industry and steam-power plants. Also, air conditioning now absorbs an important volume. Cooling towers for air conditioning are seldom large; however, many are installed. Likewise, the number of towers which are now being placed in engine-jacket-cooling service is increasing rapidly, although the average size of individual units is relatively small.

MECHANICAL-DRAFT TOWERS

For years, the mechanical-draft tower was considered only for cooling requirements where space limitations or lack of dependable breeze prohibited spray ponds or atmospheric-deck-type towers. They were very expensive, heavy, and unsightly. Objectionable drift moisture was characteristic. Operating costs were high, chiefly because of high fan-power requirements. Both

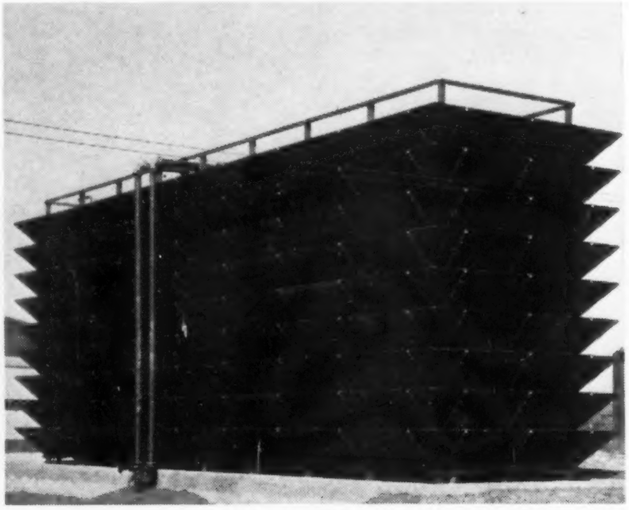
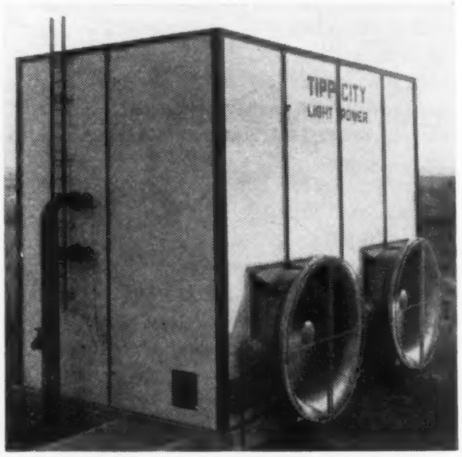
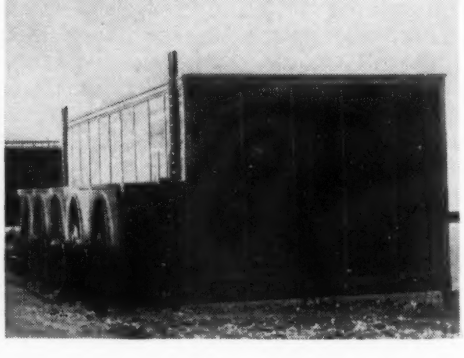


FIG. 2 THIS DECK-TYPE ATMOSPHERIC TOWER, TYPIFYING OLDER DESIGN, IS STILL IN COMMON USE

FIG. 4 TO THE LEFT IS SHOWN A 1937 FORCED-DRAFT TOWER, WITH EXTERIOR FRAME AND SEEPAGE-STRAINED SINGLE CASING. BELOW ARE PHOTOGRAPHS OF PRESENT-DAY FORCED-DRAFT TOWERS, OFTEN WITH CELLS BACK-TO-BACK, AS IN FIG. 5, DOUBLING THE WIDTH SHOWN





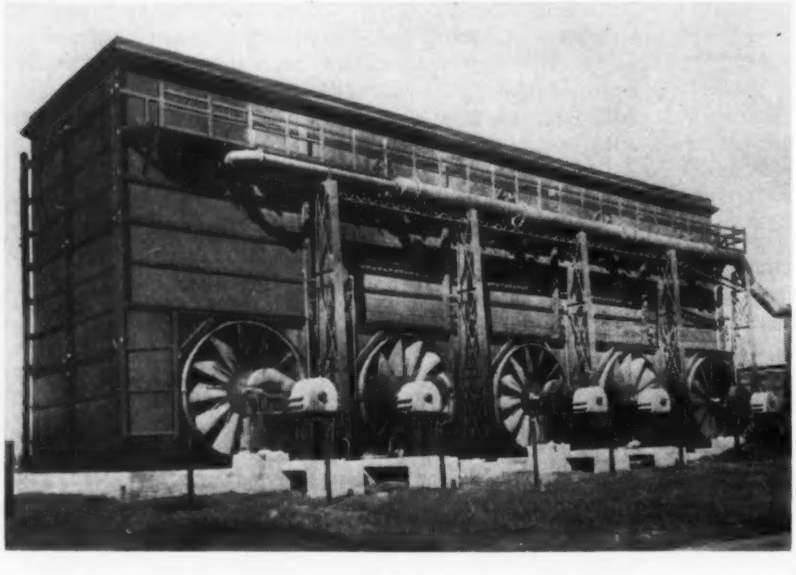


FIG. 3 REPRESENTATIVE EXAMPLE OF EARLY FORCED-DRAFT TOWER

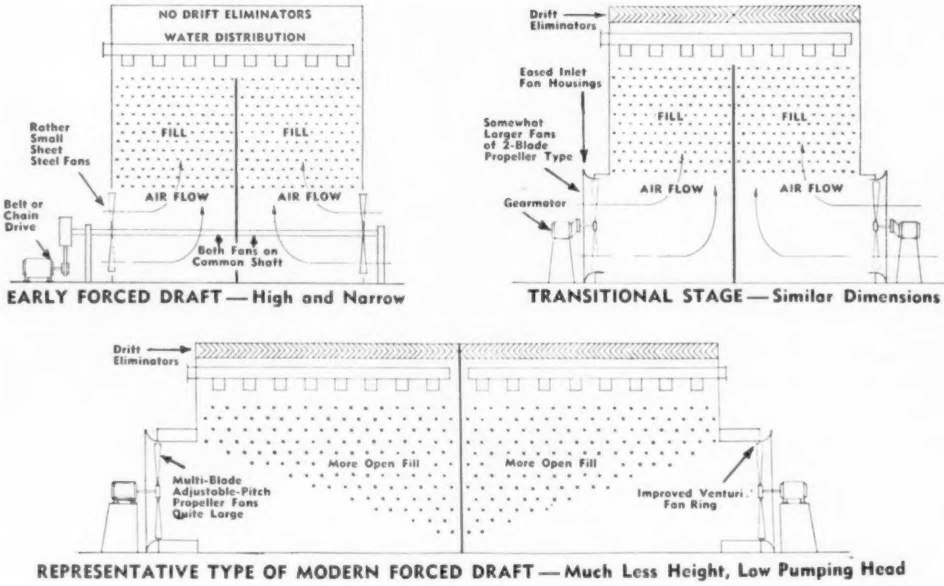


FIG. 5 SIMPLIFIED CROSS SECTIONS, ILLUSTRATING MAJOR POINTS OF FORCED-DRAFT EVOLUTION

maintenance and depreciation were abnormal, as measured by modern standards.

It may be said that the rapid growth of air conditioning, principally, led equipment manufacturers to design a new and better product, because practically none of the equipment available at the start of this growth was satisfactory to the new and more rigid requirements. Most towers in air-conditioning service are located on roofs in populous districts, so that space is restricted, the weight which can be supported is frequently limited, and noise and drift moisture are usually highly objectionable. It is further necessary to obtain the maximum cooling efficiency during the hottest of summer weather, and appearance is of great importance.

Mechanical-draft towers were obviously indicated for such service, since dependable high performance had to be maintained at all times, regardless of breeze; but it was realized that noise, drift water, unsightliness, high power consumption, and high first cost, all combined against the early-day fan-draft tower.

Recognizing these shortcomings, tower manufacturers began improving and simplifying their designs and details to reduce weight, as well as cost, and power requirements. The engineering advancement of mechanical draft was so marked and continuous that the type has developed wide popularity for nearly all classes of water-cooling work, and is today the most generally accepted means of water cooling. It is possible to design mechanical-draft towers for almost any desired approach to the wet bulb, and thus obtain longer cooling ranges and closer approaches under all conditions, than is practical with any other style of cooling equipment. Of course, as with any water-cooling equipment, the extremely close approach beyond a certain point would be prohibitive in cost.

The accepted standard in air-conditioning work is 3 gpm per ton of refrigeration rather than 5 to 6 as would be necessary with spray ponds. Even in steam-power-plant work, condensers have been so improved and operating costs have become so important that cooling ranges of 15 to 18 deg, rather than 10 to 12 deg as with spray ponds, are preferred. Comparative details of the old and new styles of equipment are illustrated herewith, and the following paragraphs point out certain changes and improvements which have taken place.

General Dimensions. The general dimensions have changed materially; area being slightly increased for a given cooling requirement, and frame height greatly reduced. Such changes permitted reduced water loads per square foot of area, smaller frame members, and less structural bracing to withstand maximum design wind conditions. Reduced height gave reduced pumping head, and increased area resulted in reduced draft loss. From total heights of between 30 and 40 ft, the trend has been downward to between 20 and 26 ft for present-day practice.

Appearance. The eye appeal of modern mechanical-draft towers is greatly superior to other styles. Former practice was to build such towers with all the structural framework appearing on the outside, applying a single wood casing to the inside of this framework, Fig. 4. This construction, while cheap, resulted in serious water leakage and exterior staining of the casing. Best modern practice is to double-case the tower with an air space provided between the two casings. Some leakage may still occur on the single inner casing, but it will drain downward to the water basin, and the outer casing will remain tight, free from leaks, and present a smooth, stainless, pleasing appearance, externally. Double casing is not necessarily subject to the objection that a casing both outside and inside the frame hides main support members, for it is used extensively now with both casings outside the framework.

Tower Weights. In larger cooling towers, there has been but

FIG. 6 RECENT INDUCED-DRAFT TOWER IN AIR-CONDITIONING SERVICE

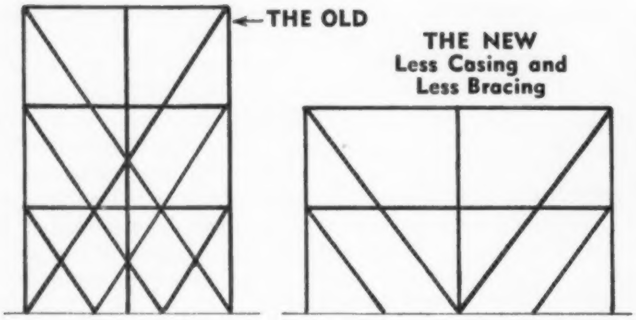


FIG. 7 STRUCTURAL SAVINGS BY NEW PROPORTIONING

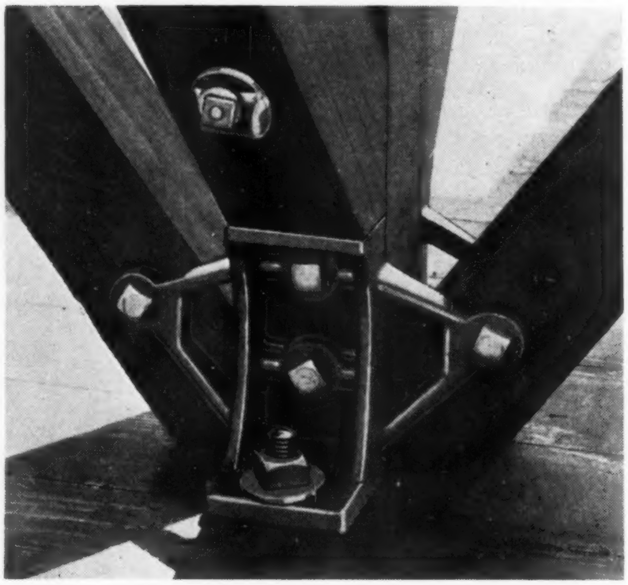


FIG. 8 STRUCTURAL HARDWARE OF CAST IRON IS A FEATURE OF MANY LATER TOWERS

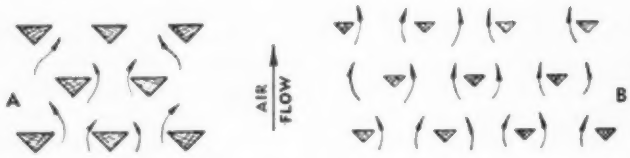


FIG. 9 AIR FLOW THROUGH FILL SLATS
(*A*, large fill slats closely spaced; *B*, small fill slats openly spaced.)

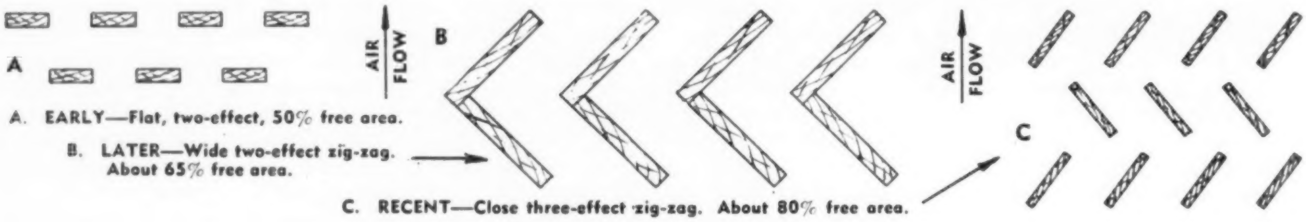


FIG. 10 DEVELOPMENT IN DRIFT-MOISTURE ELIMINATORS

little change in total weight. In smaller cooling towers, relatively high and narrow, important weight reductions have been accomplished. This is explained by the elimination of considerable casing, framework, and wind bracing, when a small tower is reduced in height and increased in area. This proportionate saving cannot be accomplished in the larger units when the height-width ratio is reduced. It is fortunate that smaller towers have been lightened, since it renders them more acceptable for mounting upon existing buildings not originally designed for unusual roof loads.

Cast-Iron Fittings. Water-inlet piping, anchor base plates (similar to Fig. 8), structural plates, and other items used in tower construction are now often made of cast iron instead of steel, as was common practice in earlier designs. The cast-iron fittings are actually lower-priced, minimize corrosion, and make for longer life. Too, they are neater in appearance and speedier to use by workmen erecting the tower.

Draft Loss. It was long a practice to require vertical air travel through the wood decking or "fill," of 15 to 20 ft, and the fill slats were so spaced that the free area through such an arrangement was approximately 60 to 70 per cent of the total effective area in the tower casing. Modern practice reduces the height, increases the area, and also uses a more effective fill with a free area for air flow of 70 to 80 per cent. Present design results in draft losses of 0.35 to 0.45 in. (water column) instead of 0.5 to 0.6 in. formerly typical.

Air Quantities. Practice in early mechanical-draft towers was about 275 to 300 fpm upward velocity through the decking or "fill" area, whereas today, with more open fill and shorter travel, velocities of 325 to 350 fpm are now commonly used for design purposes, Fig. 5. While these higher velocities with shorter travel actually result in a reduced saturation of the outgoing air, it has been found more economical to circulate the larger volume of air at lower draft loss.

Driftage. For some years after mechanical-draft towers appeared, it was not customary to equip them with "drift eliminators," and the amount of water carried away with the air approximated three to five times that of today. In fact, practically no free moisture escapes from a modern tower. Drift-loss guarantees not to exceed 0.1 or 0.2 per cent are usual, and a loss this low is so small as to be negligible, either as a cost factor, as a rust hazard to near-by machinery, or as a public nuisance. Fig. 10 illustrates developments in drift-moisture eliminators.

TYPES OF FANS

Early fans for mechanical-draft towers were usually of the sheet-steel type, commonly of the disk variety, with many blades and operating at relatively low speeds. While quiet in operation, they were inefficient and required excessive power for successful performance. Multiple-fan installations usually were arranged with long shafts extending through the tower with fans at each end, the two being driven by one motor or other source of power, Fig. 5. The complete assembly was heavy, bulky, and expensive. Airplane-propeller-type fans were introduced during 1927 and 1928, becoming generally accepted for this class of work during the next 5 years.

The early propeller fans were of two-blade one-piece construction, operating at 12,000 to 14,000 fpm tip speeds. They were efficient but very noisy. Next, the multiple-blade style was introduced, and soon thereafter the blades were independently fastened to a common hub, making it possible to ad-

just the pitch and thus vary the performance. The propeller-type wheel with adjustable pitch is now used by nearly all mechanical-draft-tower manufacturers, tip speeds averaging 9000 to 10,000 fpm, and noise levels so low as to be generally accepted without special provision. Wind-tunnel and other tests have contributed largely to the knowledge of fans, resulting in these developments.

Fan Sizes. Early mechanical-draft towers in the larger sizes employed fans of 8 to 10 ft maximum diam. These sizes were gradually increased to 11 and 12 ft, which constitute a practical maximum for forced draft. Recent induced-draft designs permit the use of larger fans, and diameters of 15 to 16 ft are now common. There are induced-draft cooling towers operating in Europe with propeller-type fans 20 to 24 ft in diameter. Larger fans mean fewer starters, less electrical wiring, and on unusually large towers they simplify operation considerably.

Fan Housings. One of the contributing factors to high fan horsepower in the earlier designs was the form of fan housing or mounting used. It was customary to cut a circular opening for the wheel in the side of the tower or housing and to set the wheel in this opening, usually with a single lightweight angle-iron ring provided for mechanical clearance. It has been proved conclusively that flared, belled, or venturi-shaped ring inlets contribute greatly to reduction of power and improved performance of fan wheels. Also, the noise level during operation is materially reduced by this means, and the reverse air flow at the blade tips is minimized, helping to reduce the winter "icing-up" nuisance, caused by "blowback" of spray water around the fans. All well-designed mechanical-draft cooling towers of today are equipped with some type of eased-inlet housings.

Motors. Commercially, it is necessary to operate fans at speeds relatively low, as compared to 1800-rpm motors which are the practical available drive. Early designs accomplished the speed reduction by the use of belting or a silent chain on the larger fans. Slow-speed motors were used on the smaller fans. Motors were usually located in the air stream which, in the case of induced-draft towers, made it necessary to operate the motor in air that was warm and excessively moist. Such locations for motors cannot be recommended.

Many improvements in speed-reducing equipment, including Tex-rope drives, gear motors, and enclosed right-angle gearboxes have been developed for cooling-tower service. The most satisfactory designs now use a right-angle gearbox with the fan wheel mounted upon the slow-speed shaft, and the high-speed drive shaft sufficiently long to permit locating the motor outside the fan ring and air stream. Splashproof motors, a development of the last few years, are entirely satisfactory for cooling-tower-fan operation, when located outside the fan ring, whereas, when located in the air stream, fully enclosed motors are desirable. For industrial towers, operating throughout the year, two-speed motors are recommended to give adequate operating flexibility and low total power consumption. Explosion-proof and weatherproof motors find most favor where fire hazards are high, as in refineries.

Ice Formation. Early mechanical-draft designs were of the forced-draft type with fans closely adjacent to, or set into, the tower shell. Falling water invariably kept the fan housing and fan wheel wet or damp, resulting in high corrosion, as well as accumulation of ice upon the fans, if operated in frigid weather. Most towers in northern climates on steam-condenser work operated with the fans shut down during the colder months of winter, depending upon natural draft for cooling effect, and many old-style towers were equipped with extended "stacks," giving a total height of 60 or 70 ft, to assist the "draw." Modern towers with their low height do not lend themselves well to winter operation without using fans. For

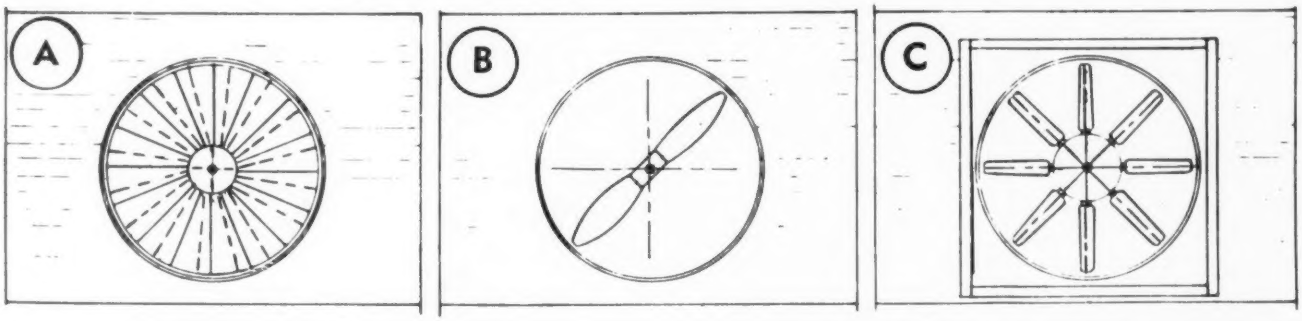


FIG. 11 TYPES OF MECHANICAL-DRAFT FANS
(*A*, sheet-steel fan; *B*, one-piece propeller-type fan; *C*, multiple-blade adjustable-pitch propeller-type fan.)

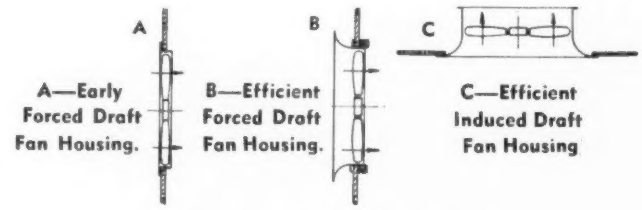


FIG. 12 FAN-HOUSING IMPROVEMENT

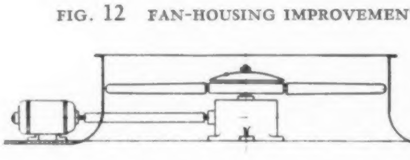


FIG. 13 MOTOR LOCATED OUT OF AIR STREAM

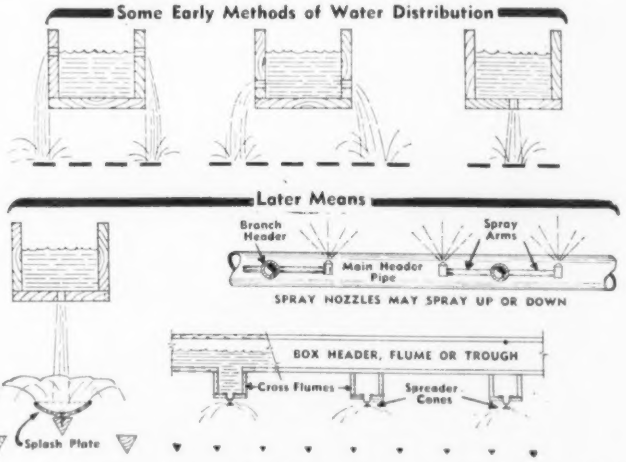


FIG. 14 VARIOUS METHODS OF DISTRIBUTING WATER WITHIN THE TOWER

this reason, the modern tower with its high-speed, lightweight aerofoil fans must be designed to operate without water accumulating upon the fan housings or wheels, thus assuring that ice will not form. Fans do not ice up in the induced-draft type of mechanical-draft towers.

Water Supply. Mechanical-draft towers of most manufacturers have undergone little change in the method of distributing water over the tower, although water is now introduced at lower levels, because of the change in tower proportions, which resulted from the demand for reduced pumping heads and operating costs. The most common distributing system uses large primary troughs or flumes from which the water flows into smaller cross troughs and from these is discharged, usually vertically, through small openings, impinging against splash plates directly for spreading. Some designs use closed piping and full spray distribution from nozzles. One new form of water distribution permits access to the distributing nozzles without curtailing the operation of any part of the tower. Some splash plates, spreader cones, and nozzles are now made from plastics.

Structural Design. Most older cooling towers were not properly designed to withstand he not less than 25- and usually 30-psf wind pressures, which are the minimum accepted standards of leading insurance companies, standardized city building codes, etc. In service, towers are seldom subjected to these maximum winds, but with the advent of air conditioning, and many potentially dangerous roof installations in congested areas, these standards are required. Best practice is generally agreed that structural strength for wind resistance should be developed within the framework through the use of diagonal bracing and bolted connections, with no allowance for nailed partitions or casing.

Insurance Requirements. Most installations within the larger cities must be of designs to meet rigid city building-code requirements, and many of the larger cities require that such structures be fireproof, thus eliminating towers of wood construction. Steel towers usually cost 30 to 50 per cent more than similar towers of wood. Many of the larger purchasers of cooling towers require the manufacturer to submit his designs for check and approval by recognized insurance companies.

Lumber. Probably 90 per cent of all cooling towers built are of lumber, and in commercial use California redwood is most popular, with good Gulf or swamp cypress also being used in less quantities. Redwood is fairly light, easily worked, of long life, and readily available. Cypress is an excellent lumber but not readily obtainable. Only heart lumber should be used in cooling-tower work, as sapwoods tend to rot rapidly. Full and complete information on lumber is available through authoritative handbooks published by the U. S. Forest Products Laboratory at Madison, Wis. These publications are the generally accepted standards for design.

Noise. In cooling-tower work noise is created in two ways. Fans and drive equipment produce the most serious amount. The secondary source, that of falling water within the tower, is seldom objectionable and can be neglected for ordinary applications. However, fan noise can frequently be of such volume that it becomes impossible to ignore it. Whenever cooling towers are located in residential areas or adjacent to office buildings, etc., consideration must always be given to the prevailing noise levels. It is now possible to measure noise by standardized decibel meters, and noise levels of cooling towers can be closely predicted. It is to be noted that towers having the fans located at the top, and operating on the induced-draft principle, seldom have difficulty of this nature, since any noise produced usually travels vertically and so does not reach near-by buildings.

Air Recirculation. A common difficulty experienced with forced-draft towers, especially in the larger multiple-fan installations, is the tendency of the outgoing air, leaving the tower at low velocity, to travel horizontally and be drawn downward in the fan currents to re-enter the tower and thus reduce cooling efficiency because of the hot saturated condi-

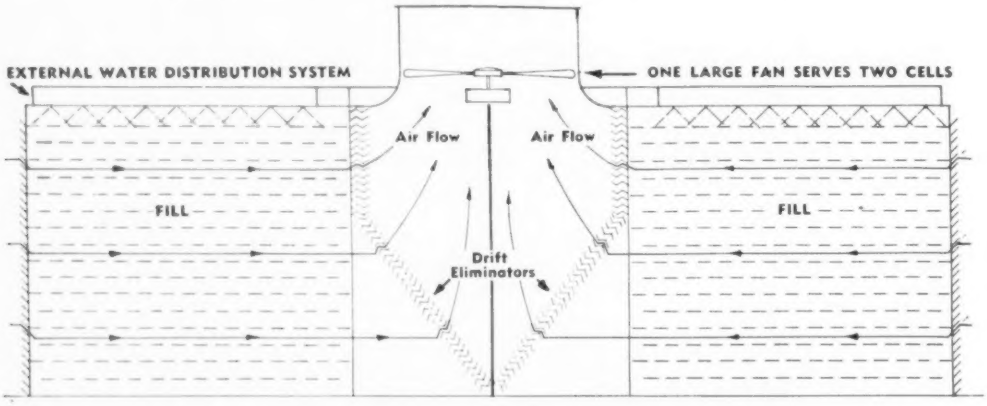
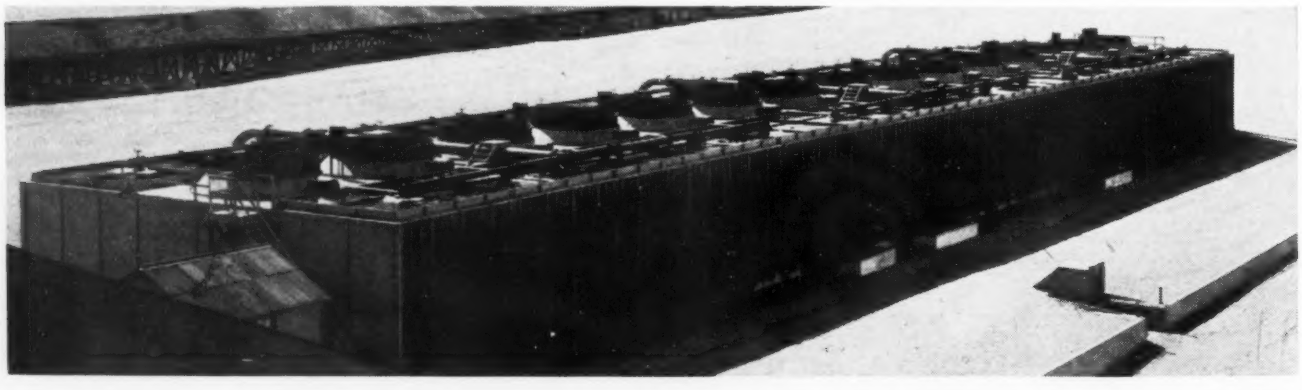


FIG. 15 RECENT VARIATION OF INDUCED-DRAFT DESIGN FOR UNUSUALLY LARGE CAPACITIES
(Photograph shows a 15-fan, or 30-cell, tower of this type.)



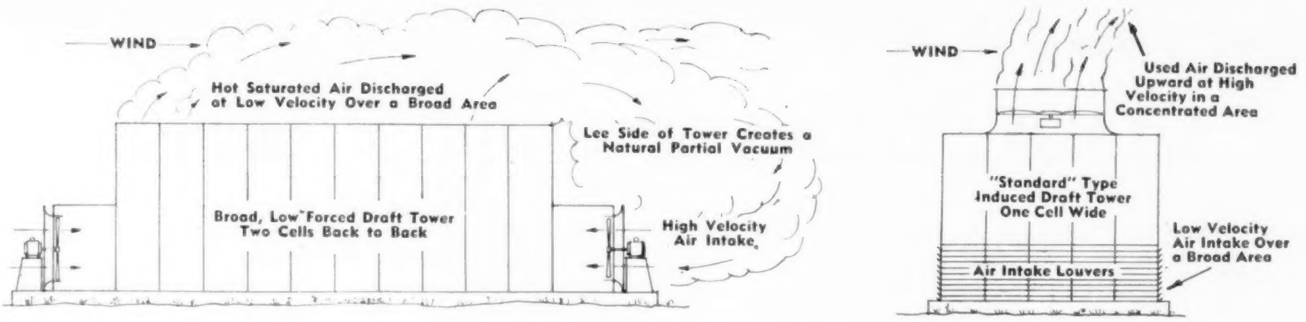


FIG. 16 CONTRASTING THE SUSCEPTIBILITY OF FORCED DRAFT TO RECIRCULATION WITH THAT OF INDUCED DRAFT

tion of this used air. Such recirculation frequently nullifies 12 to 15 per cent of the tower capacity, which means that either a larger tower than would otherwise be necessary must be used or the cooling results may prove unsatisfactory. Where such conditions are likely to occur, it is well to use towers of the induced-draft type from which air discharges vertically at relatively high velocity, or to extend the tower casing upward to such height as to combat any probability of this objectionable cycle taking place. This explains the marked and rapid trend toward supplanting forced-draft with induced-draft systems for large multiple-fan installations.

Tower Loads. The practical loadings of towers, in gallons of water per square foot of effective tower area, will usually come within a range of 2 to 6 gal. The average or difficult cooling requirements necessitate lighter loadings, while the relatively shorter cooling ranges with wide approach to wet bulb permit the heavier loadings of between 5 and 6 gal per sq ft. Most tower manufacturers consider it poor practice to design for greater loadings or reduced areas, because under such conditions, draft loss is excessive with reduced air quantities, and it becomes difficult to calculate actual results obtainable.

Design Weather Data. In proper design and application of water-cooling towers, accurate knowledge of wet-bulb conditions at the geographical location intended is imperative, and such information in earlier days was frequently not readily available. Now, however, comprehensive and reliable data covering local weather conditions throughout the United States exist in book form, and this has been of immeasurable value to manufacturers of water-cooling equipment. Its proper application helps assure that the unit selected is of proper size and makes possible dependable performance predictions.

Research. The water-cooling-equipment industry is relatively small, with a business volume varying from \$2,000,000 to \$3,000,000 in ordinary years. This is divided among twelve to fifteen manufacturers. While some of the leaders make a practice of improving their products continuously and studying product applications, very little basic research has been accomplished. It is gratifying to note that, during the last 2 or 3 years, research has been carried on steadily by the University of California with funds made available from several sources, including the American Society of Heating and Ventilating Engineers, and a few water-cooling-equipment manufacturers. Several very interesting and highly technical papers from this source have been published.

The most important points brought forth in this paper are summarized in Table 1, which compares significant data on three representative sizes of towers for the years, 1925, 1932, and 1941. The information given is for towers completely installed upon concrete foundations provided by others. The figures do not include the cost of electric wiring, starters, foundation, or water piping beyond the tower connection.

A brief study of Table 1 will indicate clearly that operating costs are being reduced constantly, with comparable reductions in fan horsepower and water pumping head, while at the same time the actual delivered and erected cost for the more improved product is also declining. Appearance is better, drift loss has been eliminated, and the number of fans required is being reduced steadily. This tabulation further indicates why today mechanical-draft towers are gaining preference over atmospheric towers or spray ponds. In these two latter types little improvement or modernization has taken place. Their relative costs have actually risen due to increased labor and material costs which also affect mechanical-draft equipment proportionately. However, in the case of mechanical-draft towers, these factors have been offset by aggressive improvement, simplification, and closer adaptation to the specific requirements of each application, every opportunity being seized to make wise reductions in cost of production and operation.

TABLE 1 COMPARISONS SHOWING PROGRESSIVE IMPROVEMENT AND DECLINING COSTS

	1000 Gallons			5000 Gallons			20000 Gallons		
Description	1925	1932	1941	1925	1932	1941	1925	1932	1941
Dimensions—W x L	18x24	19x24	20x24	22x96	30x72	30x80	36x220	26x240	40x240
Height	38′	36′	24′	40′	36′	26′	40′	36′	26′
Effective Area	432	456	480	2112	2160	2400	8420	8640	9600
Fans—Number	2	2	1	6	6	4	22	24	10
Size	9′	9′	11′	11′	11′	13′	12′	11′	16′
BHP Each	14.25	11.3	19.03	28.4	19.15	24.0	30.05	19.15	38.4
BHP Total	28.50	22.6	19.03	170.4	114.9	96.0	671.0	459.6	384.0
Weights—Dry	57000	48000	40000	280000	260000	240000	960000	940000	900000
Water Pumping Head	25′	25′	20′	27′	27′	20′	28′	28′	20′
Price—Delivered and Erected	\$6000	\$5500	\$5300	\$22000	\$20000	\$19000	\$78000	\$71000	\$67000

Substitution of

MOLYBDENUM *for* TUNGSTEN

HIGH-SPEED STEEL

SINCE 70 to 85 per cent of the tungsten consumption is in high-speed steel, the chief opportunity for conservation lies in substitutes for tungsten in this composition. Development of such substitutes within the last fifteen years has produced compositions which in most applications are acceptable, though as noted below, some of these create new problems in the availability of additional equipment which these substitute compositions require.

The composition of high-speed steel is given in Table 1. T-1 and three types of molybdenum high-speed steel, in the order of decreasing tungsten content, available for possible substitution, are listed. Ranges (except for M-1) of composition are not given, nor are they given generally in this report, for the reason that many variations are found; the compositions given are therefore to be taken as typifying the steel but not as defining its limits. Modifications of these compositions are frequently employed.

TABLE 1 COMPOSITION OF HIGH-SPEED STEELS T-1, M-1, M-2, AND M-3

	T-1	M-1	M-2	M-3
Tungsten, per cent	18	5.0–6.0	1.5	...
Molybdenum, per cent	...	3.5–5.5	9.0	7.0–9.0
Chromium, per cent	4	3.5–4.5	4.0	4.0
Vanadium, per cent	1	1.25–1.75	1.0	2
Carbon, per cent	0.70	0.60–0.90	0.80	0.80

The M-1 type can be handled in the shop very much as can the T-1 tungsten steel. It is reported that it can be heat-treated in the same equipment and with the same technique as T-1. Apart from heat-treatment schedules, the chief difficulty in the substitution of molybdenum lies in greater decarburization, with resultant increased costs, and complications and loss of time in processing schedules. The M-1 type is much less susceptible to decarburization than either M-2 or M-3, showing little or no difference from T-1 in this respect. The M-2 and M-3 types are both susceptible to decarburization. There is little difference in this respect between these two types.

Allegheny-Ludlum Steel Corporation has a patent on a steel of type M-1 and has offered it, without charge, to all manufacturers. The Cleveland Twist Drill Company has a patent on type M-2, and many major tool-steel manufacturers are licensed. The Vanadium Alloys Steel Company and the Crucible Steel Company have patents on steels of the M-3 type and have offered them, without charge, to all manufacturers. All three types are in wide use; the exact proportions are difficult to determine and are changing at the present time. All have good cutting properties and, apart from differences and difficulties in processing, are suitable substitutes for 18-4-1. Complete substitution of 18-4-1 by the compositions given would save one half to three quarters of the tungsten consumed in 18-4-1. Since some of the substitute compositions listed in this section require more vanadium than T-1, a new difficulty may be created with respect to the availability of vanadium.

There are many modifications in the compositions of high-speed steels, both with molybdenum substituted for tungsten in whole and in part. Table 2 shows variations with compositions of molybdenum high-speed steels suggested for use in place of the tungsten (T) steels. Other modifications are available. Table 1 gives merely types of substitution; Table 2 gives a fuller account, though as stated it is suggestive and not restrictive.

TABLE 2 TUNGSTEN HIGH-SPEED STEELS AND MOLYBDENUM SUBSTITUTIONS

Present types of tungsten high-speed steels	W	Cr	V	Co	Suggested molybdenum substitutions	W	Mo	Cr	V	Co
	Per cent					Per cent				
					M-3	...	7–8	4	2	....
T-1	18	4	1	..	M-4	...	9	4	3	(High C)
T-2	18	4	2	..	M-5	1.5	9	4	2	....
T-3	14	4	2	..	M-2	1.5	9	4	1	....
					M-1	5–6	3.5–5.5	3.5–4.5	1.25–1.75	....
					M-7	6	6	4	1.5	....
					M-6	5.5	4.5	4.5	4	
					M-8	...	8	4	1	2.5 B
TC-1	18	4	1	5	M-9	...	8	4	1.5	8 B
TC-2	18	4	2	8	M-10	1.5	8	4	1	5
TC-3	14	4	2	5	M-11	1.5	6.5	4	2	5
					M-12	1.5	8	4	2	8
					M-13	6	6	4	1.5	6

Some manufacturers and users do not regard the suggested molybdenum substitutes as proper, while others do; it has been questioned, for example, whether M-7 is a proper substitute for T-1 in all applications. Certain of the suggested substitutes are expensive; others are "special-purpose steels" not of wide usefulness; again, others are difficult of manufacture. The usefulness of boron additions has been questioned; it is said that cobalt increases the difficulties in decarburization.

The molybdenum high-speed steels, with or without tungsten, can be substituted for the tungsten high-speed steels rather sweepingly. It is reported that there are places in which a substitution will represent a quality impairment, and that there appear to be applications where a satisfactory substitution cannot be made; but if good judgment is exercised by both manufacturer and user, this can be kept to a low minimum. Substitution with resultant quality impairment must be kept to a low minimum, for quality impairment, in a time when production schedules must be maintained at the highest possible level, is a dangerous thing. Emphasis should be laid upon substitution for T-1, for this steel represents the largest consumption of tungsten; if such substitutions were made, little attention would have to be given to substitution for the other steels and for the other tungsten steels mentioned elsewhere in this report; such a policy would result in minimum disruption in industrial processing.

Manufacturers and consumers can effect a large degree of substitution by cooperative effort. An appreciable substitution has already been accomplished by companies which direct their salesmen to recommend substitutions to customers wherever possible. Such substitution results in growing stocks of secondary tungsten which, in time, tends to relieve the pressure

From a report of the Advisory Committee on Metals and Minerals, Zay Jeffries, chairman, of the National Research Council, National Academy of Sciences.

Three reports on the heat-treatment of molybdenum high-speed steel appeared in the October, 1941, issue of MECHANICAL ENGINEERING, pages 703–705. EDITOR.

in primary tungsten. Although not noted in the foregoing, it should be said that a greater use of cemented carbide tool materials (see comment on these elsewhere in this report) would result in appreciable savings in tungsten. A greater use of tipped tools would save the material in the tool stock.

The substitution of the M-type steels noted will require changes in processing except, it is reported, in the case of M-1 which may be heat-treated in the same equipment and with the same technique as T-1. Heat-treatment temperature schedules vary somewhat from those employed for tungsten steels, but these are known. Steels of the types M-2 and M-3 have a greater tendency to decarburize than the tungsten types T-1, T-2, and T-3 or the molybdenum-tungsten type M-1, and for this reason their surface must be protected during manufacture and during heat-treatment; for tools to be ground after heat-treatment this is not a serious difficulty. Suitable protection is afforded by a borax or copper-base paint coating or by a reducing atmosphere so adjusted as to avoid excessive carburization; special atmospheres require special furnaces which are now difficult to procure; salt baths have been useful in heat-treatment in this respect. This difficulty will be the greater for the very large number of small users of high-speed steel and the lesser for the small number of large users, for the latter often already possess the necessary equipment, whereas the former do not.

ALLOY TOOL STEELS

Listed in Table 3 are a number of compositions of low-alloy tool steels containing tungsten, with suggested molybdenum substitutes; substitution should be approached with caution and adopted only after trial.

TABLE 3 MOLYBDENUM SUBSTITUTES FOR LOW-ALLOY TUNGSTEN TOOL STEELS

Low-alloy steels containing tungsten		Suggested molybdenum substitutes	
T-4	0.85–1.0 C, 0.30 Si, 1.3 Mn, 0.45 Cr, 0.45 W, 0.10–0.25 V	M-14	0.95 C, 0.30 Si, 1.3 Mn, 0.50 Cr, 0.25 Mo, 0.20 V
			(NOTE: See comment on nonmolybdenum substitutes)
T-5	0.45 C, 0.3 Mn, 0.30 Si, about 2.0 W, 1.5 Cr, 0.25 V	M-15	0.6 C, 0.9 Mn, 1.9 Si, 1.3 Mo, 0.3 V, 0.2 Cr
		M-16	0.5 C, 0.7 Mn, 1.6 Si, 0.6 Mo, 0.2 V
		M-17	0.6 C, 1.0 Mn, 2.0 Si, 0.5 Mo, 0.3 V
		M-18	0.5 C, 1.0 Mn, 2.0 Si, 1.35 Mo, 0.5 V
		M-19	0.5 C, 0.4 Mn, 1.0 Si, 0.5 Mo
		M-20	0.45 C, 0.3 Mn, 0.3 Si, 1.0 Mo, 1.5 Cr, 0.25 V
		M-21	0.6 C, 0.8 Mn, 0.3 Mo, 1.9 Si
			(NOTE: See comment on nonmolybdenum substitutes)
T-6	1.30 C, 3.6 W, 0.25 Cr	M-22	1.25 C, 2.0 Mo, 0.25 Cr
		M-23	1.1 C, 0.3 Si, 1.3 Mo, 1.2 Cr, 0.4 W, 0.3 V
			(NOTE: See comment on nonmolybdenum substitutes)
T-7	1.25 C, 0.3 Mn, 0.75 Cr, 0.2 V, 1.4 W	M-24	1.3 C, 0.3 Mn, 0.75 Cr, 0.2 V, 0.75 Mo
			(NOTE: See comment on nonmolybdenum substitutes)

It is *very important* to note that the substitutes suggested are molybdenum substitutes *only*. There are other and, it is said, better substitutes containing neither tungsten nor molybdenum. These will be dealt with in other reports of this committee; the present report is concerned only with the substitution of molybdenum for tungsten. The recommendations made in this section, therefore, have far less weight than those in other sections. The amount of tungsten consumed in these steels is small.

STELLITE

About 2 per cent of the yearly consumption of tungsten is employed in the manufacture of stellite. Stellite is a nonferrous alloy of which several compositions are made. One of these is: Co—45–50, Cr—31–35, W—12–15. Other compositions run toward higher cobalt (up to 68 per cent) and lower tungsten (down to 3 per cent), with chromium remaining practically constant. Such tool materials, owing to the small quantities used, consume but little tungsten; because of their unusual cutting qualities their use offers some opportunity to conserve tungsten. The substitution of molybdenum for tungsten has been attempted with but little success, and this or other substitute in stellite is not recommended.

TUNGSTEN-CARBIDE TOOLS

About 5 per cent of the yearly consumption of tungsten is employed in the manufacture of tungsten-carbide compositions. Other carbide tool materials containing tantalum carbide, titanium carbide, etc., together with tungsten carbide, are in wide use. These various types of carbide tool materials find varied, and often specialized, uses; occasionally they are not interchangeable. Such tool materials, owing to the small quantities used, consume but little tungsten; owing to their unusual cutting qualities, their use offers an opportunity to conserve tungsten, particularly in single-cutting-point application where their use could be increased.

DIE STEELS FOR HOT WORKING

There are listed in Table 4 a few compositions of die steels containing tungsten, used mainly in the hot-working of metals.

TABLE 4 MOLYBDENUM SUBSTITUTES FOR DIE STEELS CONTAINING TUNGSTEN

Die steels containing tungsten		Suggested molybdenum substitutes	
T-8	0.3 C, 5.0 W, 5.0 Cr	M-25	0.3 C, 5.0 Cr, 0.9 Si, 1.25 Mo
T-9	0.3 C, 1.25 W, 5.0 Cr, 1.25 Cr	M-26	0.35 C, 3.5 Cr, 6.0 Mo, 0.75 V, 1.0 W
T-10	0.3 C, 3.25 Cr, 9.0 W, 0.25 V	M-27	0.6 C, 3.5 Cr, 8.5 Mo, 1.75 V
			(NOTE: See comment on nonmolybdenum substitutes)

A few substitutes for them are suggested containing molybdenum with less or with no tungsten. There are many other die steels containing tungsten, not listed; important substitutes containing neither tungsten nor molybdenum are not listed. Substitutes should be approached with caution and adopted only after trial. The amount of tungsten consumed in these steels is minor.

VALVE AND VALVE-INSERT STEEL

Many exhaust-valve insert seats and the exhaust valves for aircraft engines are made from an alloy containing tungsten as follows: 0.45 C, 0.70 Mn max, 0.50 Si, 14.0 Ni, 14.0 Cr, 2.5 W, 0.35 Mo. Both Wright and Pratt and Whitney are using this steel; any change at the moment would be very inadvisable. A composition is available for insert seats closely corresponding to this, except silicon ranges from 2.75 to 3.25.

It is reported that relatively large quantities of the following molybdenum-steel are being sold for use as valve-insert and exhaust-valve steel and as intake-seat steel: 0.70 C, 0.50 Mn, 1.0 Si, 3.0 Cr, 5.0 Mo.

Intake valves for aircraft engines are now made from alloys of the following compositions:

(1) 0.55 C, 0.30 Mn, 3–4 Cr, 13.5 W
(2) 0.30 C, 0.50 Mn, 12–13.5 Cr, 2–3 Si, 7–8.5 Ni

It has been said that these two compositions are not to be taken as interchangeable for this application; the Pratt and Whitney engine requires (1) and the Wright (2); but other engineers believe that all intake valves may be made of (2) if the necessity arises.

It is reported that a satisfactory substitute for intake valves in lower-horsepower engines (but not for the present high-horsepower engines) has been employed, of the following composition: 1.35 C, 12.25 Cr, 0.65 Mo, 3.0 Co. The use of this alloy is slight; the substitution of tungsten by cobalt may be questionable on the basis of availability of cobalt. Work is now actively under way on possible substitutes for (1) and (2) for the newer engines. It is suggested that (2) may replace (1), or vice versa, in accordance with the availability of tungsten, chromium, and nickel.

ARMOR-PIERCING PROJECTILES AND BULLET INSERTS

The substitution of molybdenum for tungsten in these materials is now under study. Col. S. B. Ritchie, of Watertown Arsenal, reports that complete substitution can be effected if the necessity arises, provided that some sacrifice in ballistics efficiencies can be tolerated and production difficulties, which may arise in the new materials, can be satisfactorily handled. If this should be done, it will go far to avoid a shortage of tungsten. There is no requirement of tungsten in armor plate, according to Colonel Ritchie.

MAGNET STEELS

The total tungsten consumption for permanent magnets is very small. Formerly, large quantities of permanent-magnet steel were used of the following composition: Tungsten 5–6 per cent, carbon 0.70 per cent. This has been largely replaced and can still further be replaced by a chromium steel of the composition: Chromium 3.5 per cent, carbon 0.95 per cent.

The newer permanent-magnet compositions of aluminum, nickel, cobalt, and iron have replaced large quantities of the two compositions just mentioned. These are cast or sintered (powders) of the following compositions

(1) 12 Al, 20 Ni, 5 Co, balance Fe
(2) 10 Al, 17 Ni, 12 Co, 6 Cu, balance Fe

The chromium magnet steel listed will probably best serve the purpose of conservation, except in special applications where the special properties of the aluminum-nickel-cobalt composition make them irreplaceable.

ELECTRICAL APPLICATION

About 1.5 per cent of the tungsten consumed is employed in the manufacture of electric equipment—lamps, X-ray tubes, radio tubes, etc. The quantity is insignificant and substitution of molybdenum is not possible in most of these uses.

TUNGSTEN RECLAMATION

It is said that appreciable amounts of tungsten could be made available for use by more complete segregation and reclamation of tungsten scrap, and it is suggested that a campaign with this aim should be forwarded.

Fuels and Lubricants in National Defense

(Continued from page 782)

with dirt and grease and this builds up pressure and blows out seals. The housings are overfilled and the 20 per cent expansion caused by running temperatures builds up excessive pressures. The vents on the front and rear axles should have a flexible extension to keep mud from choking them or when the vehicle is stalled in a mudhole or stream to keep water from leaking into the housing.

Motor officers who were interviewed in the field felt that the lubrication failures that occurred were traceable to either mixing application or mechanical design. The few men who were in former maneuvers said there was at least a 25 per cent improvement, even though this is the largest maneuver ever staged in America. The Third Army will use approximately 12,000,000 gal of gasoline, 240,000 gal of engine oil, and 300,000 lb of grease in the Louisiana maneuvers in less than 60 days. The Second Army in Arkansas will use even more.

The next largest number of failures in lubrication was in wick-fed generator bearings, generally on the commutator side, which burned out because inadequate oiling caused the wick to char. The instructions call for sparse oil as over-lubrication will allow oil to get on commutator. Surely if the grease-packed-bearing experience of the electric-motor industry were applied here, such a bearing would run without attention for long periods and no attention between 5000 mile periods would be needed.

LUBRICATION CHARTS

The charts or lubrication guides developed by the Ordnance Department Field Service in connection with the "Chek Chart" for Ordnance tanks, tractors, guns, and trucks are complete and are based on the U. S. Army Standard Nomenclature for Automotive Lubricants and Specialties as set forth by the War Department Committee on Liquid Fuels and Lubricants. See Table 1 on page 782. Some of the field forces feel that the charts are too wide in scope for operations and should be reduced to the climate or temperature range of the particular maneuver or combat area in which certain motorized and armored equipment is operating. However, for the motor officer these Ordnance-developed charts are a step forward for the War Department in standardization of fuels and lubricants.

Even though this country, after a year of planning, is ahead of the British today, there is need of a closer broad-range program along the line of the petroleum products specified on the simplified charts now in production for the motor and armed forces both for tactical operation and detached service. This goal of perfection is now being handled for the Army through the War Department Committee on Liquid Fuels and Lubricants and by the Navy through the Bureau of Ships and Bureau of Aeronautics.

Industry would do well to cooperate by converting its equipment requirements to the standard nomenclature for fuels and lubricants, as set up by these two sources for National Defense equipment.

COAL-HANDLING SYSTEMS *for* CENTRAL STATIONS

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THE economical handling of coal to insure an uninterrupted supply to the boilers is one of the major problems in the design of central stations and differs from most other design problems in the great number of variables which exist and the numerous combinations of equipment and methods which can be used. The method of receiving the coal at the plant is usually one of the deciding factors in the general layout. If coal is received by water in large lake or ocean-going vessels, rapid unloading facilities are necessary in order to avoid demurrage. For this purpose movable towers with large grab buckets are used. For river transportation, open coal barges are used, and it is the general practice to use stationary unloading towers with grab buckets for unloading. On the Great Lakes, the use of self-unloading vessels is becoming more prevalent and this materially reduces the coal-handling equipment required.

Some central stations are located at the mouth of the mine and receive their coal directly from the mine in mine cars. Coal received by rail generally comes in hopper-bottom dump cars, but in some localities coal is shipped in flat-bottom cars which may or may not be provided with dump bottoms. Such cars must be unloaded with a grab bucket or by means of a car dumper. Delivery by truck from near-by mines is becoming more prevalent, and provisions for such delivery have been made at many of the plants.

The complexity of the problem prevents the detailed description of even representative systems in the scope of this paper. However, two definite trends in the handling of coal should be noted.

TRENDS IN COAL-HANDLING METHODS

With the increasing market for coal for household stokers and with the increasing use of pulverized fuel in central stations, the size of coal that is being used by many central stations has decreased from $1^1/_4$-in. screenings to $^3/_8$-in. screenings or less. The use of fine coal has resulted in greatly increasing the time required to unload hopper-bottom cars, especially if the coal is wet, so that the coal-handling capacity in those plants which obtain their coal in hopper-bottom cars and unload by gravity into a pit may be seriously reduced. The packing of the fine coal in the bunkers has presented a serious problem which has not been adequately solved.

The use of bulldozers for compacting coal piles has been employed for at least 15 years, and has recently become quite common. This has resulted in practically eliminating any danger from spontaneous combustion. Consequently, the necessity for using storage and reclaiming equipment, having large digging capacity to dig out fires in the coal storage pile, has been eliminated with a corresponding saving in initial investment. The use of the bulldozer for moving coal short distances and the addition of a carryall to the bulldozer to move coal over considerable distances is finding increased favor. With this equipment, the initial investment is very low, and it has the advantage that capacity can be increased readily by additional units.

COMPARISON OF COAL-HANDLING COSTS FOR VARIOUS SYSTEMS

A comparison of coal-handling costs for a number of different coal-handling systems is shown in Table 1. The installation costs given are the original costs, plus additions, less retirements, and include all of the investment chargeable to coal-handling equipment except the coal bunkers in the plant, and include such items as coal docks, turning basins, unloading towers, cranes, conveying and elevating equipment, coal crushers, railroad tracks, and track hoppers.

The load factors on the coal-handling equipment given in the tabulation are based on the total coal consumed per year and the handling capacity to the bunkers. As would be expected, they vary over a wide range. The low load factor of coal-handling equipment is due to several factors. The capacity of the equipment is normally designed to provide for future increases in coal consumption, if not for the ultimate size. In order to allow time for repairing breakdowns, the capacity must be sufficient to coal the plant at maximum load in at least two of the three shifts per day, and it is usually figured to do so in one shift of 8 hours. Thus, for a central station having a yearly load factor of 60 per cent, the load factor on the coal-handling equipment would be 20 per cent to allow the plant to be fueled in 8 hr of continuous operation of the coal-handling equipment at its full capacity. Since coal-handling equipment can seldom be operated continuously at full capacity, due to the delays in spotting boats or cars, to difficulties encountered with the functioning of the equipment, or to foreign matter in the coal, the load factor will be somewhat lower than that just indicated if the fueling of the plant is to be accomplished in an eight-hour shift.

It will be noted that the highest load factor shown is 33 per cent but, at this plant, the coal-handling facilities have become inadequate in capacity and are being replaced. The average load factor on the coal-handling equipment for the plants listed is 14.6 per cent. Several other plants, not listed in the table, having coal-handling capacities of 500 tons per hr and designed for the ultimate size of the plant, have had an average load factor on this equipment of 11.1 per cent since their installation some 14 to 20 years ago.

The maintenance costs, given in Table 1, show an average cost for thirteen systems of 3.6 cents per ton of coal burned. The method of recording maintenance costs varies somewhat among the different plants. Some plants do not segregate the maintenance costs between coal- and ash-handling equipment, but these differences have been adjusted so as to arrive at maintenance costs that are comparable for the period represented. Maintenance costs should be averaged over a period of years so that the complete maintenance cycle is represented. Some of the plants listed have so recently been installed that the maintenance is unduly low, while other plants may have had unduly high maintenance costs for the period which is represented by the

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TABLE 1 COMPARISON OF COAL-HANDLING COSTS

Plant designation	Coal delivered by water, rail, or truck	Year installed	Capacity to bunkers tons per hour	Cost of installation including docks, tracks, pits, cranes, conveyors, etc.	Years represented by data	Tons coal burned per year	Load factor on coal handling equipment	Maintenance cost cents per ton	Operating labor cents per ton	Total operating costs cents per ton	Fixed charges based on 12% per annum, cents per ton	Total fixed and operating costs, cents per ton	Description of System
A	W	1939	400	$ 691,000	1940	124,000	3.5	1.3	5.0	6.3	67.0	73.3	Coal delivered on dock by self unloading lake boats, gantry crane to storage, or to belt conveyors to plant.
B	W	1925	350	1,220,000	37-39	382,046	12.5	5.3	7.6	12.9	38.1	51.0	Gantry crane from lake boats to storage, or by car and belt conveyor to plant. Auxiliary drag line storage.
C	W	1926	250	655,000	38-40	547,574	25.0	4.2	4.0	8.2	14.4	22.6	Clam shell from river barges to belt conveyors to plant or to Lidgerwood storage.
D	W	1928	125	978,000	35-40	175,879	16.1	4.8	6.6	11.4	66.8	78.2	Clam shell from ocean steamers or barges to belt conveyors, to plant or to drag line storage.
E	R	1939	200	360,000	1940	196,000	11.2	.7	6.1	6.8	22.0	28.8	Cars discharge by gravity into pit, to belt conveyors, to plant or to drag line storage.
F	R & T	1939	125	160,000	1940	122,924	11.2	4.5	6.4	10.9	15.8	26.7	From cars by gravity to pit, to belt and bucket elevator, to drag line storage or to plant by belt.
G	R	1936	100	212,000	1940	79,360	9.1	1.9	7.5	9.4	32.0	41.4	From cars by gravity to pit, to belt and bucket elevator, to drag line storage or to plant by belt.
H	R	1913	75	66,000	38-38	109,000	16.7	2.4	5.3	7.7	7.3	15.0	Stationary tower with clam shell bucket from cars to distributing belt. Locomotive crane for storage.
I	R	1925	75	112,000	36-36	217,588	33.0	2.1	4.4	6.5	6.3	12.8	Locomotive crane with bucket unloads cars to pit, to chain and bucket elevator, to scraper conveyor. Locomotive crane for storage.
J	R	1927	60	160,000	38-40	62,606	11.9	6.1	9.8	15.9	30.7	46.6	Cars discharge by gravity into pit, to belt and bucket elevator, to scraper conveyor. Locomotive crane for storage.
K	R	1928	60	164,000	37-39	43,860	8.3	4.9	10.1	15.0	45.6	60.6	Cars discharge by gravity into pit, to belt and bucket elevator, to scraper conveyor. Bridge crane for storage.
L	R	1926	50	97,000	37-39	54,636	12.4	4.8	8.1	12.9	21.5	34.4	Cars discharge by gravity into pit, to belt and bucket elevator, to scraper conveyor. Bridge crane for storage.
M	R	1920	40	20,000	39-40	40,077	11.4	3.4	6.7	10.1	6.0	16.1	Cars discharge by gravity to shallow pit, to inclined scraper conveyor, to bunkers. Storage by portable conveyor.
N	R	1937	150	185,000	1940	275,376	21.0	-	-	10.6	8.1	18.7	Cars dump into pit, to skip hoists, to belt distributors. Storage by locomotive crane and bulldozer.
						Average	14.6	3.6	6.7	10.3	27.2	37.6	

data. However, the average maintenance cost of 3.6 cents per ton for the plants listed is believed to be fairly representative for coal-handling equipment in central stations.

MAINTENANCE COSTS OF TWO-ELEVATOR SYSTEMS

The cost of maintenance varies for the different kinds of equipment used, but this variation is no greater than the variation shown between similar pieces of equipment in different plants. The cost of maintenance appears to depend more upon the design of seemingly trifling details of the equipment than upon the choice of the equipment itself, and close attention to these details by the purchaser's engineers will be amply repaid by lower maintenance costs and also by increased reliability. The variation in maintenance costs for similar equipment is illustrated, in Table 2, by the records of two installations of belt-and-bucket elevators.

While the maintenance cost, which largely results from

TABLE 2 COMPARATIVE DATA FOR TWO BELT-AND-BUCKET ELEVATOR INSTALLATIONS

	A	*B*
Years in service	10	8
Capacity, tons per hr	50	60
Speed of belt, fpm	250	135
Size of buckets, in.	16 × 8	16 × 8
Bucket material	10-Gage steel	Malleable iron
Center to center of buckets, in.	24	12
Width of rubber belt, in.	18	20
Belt ply	6	8
Rubber cover, in.	$^1/_{16}$ One side	$^1/_{16}$ Both sides
Head pulley diameter, in.	30	36
Tail pulley diameter, in.	20	30
Center to center of pulleys, ft-in.	94-9	100-0
Total coal handled, tons	579,715	268,932
Maintenance cost, total	$689.65	$642.29
Maintenance cost per ton	0.12 Cent	0.24 Cent

bucket replacements, is comparatively low on both elevators, that of the cheaper elevator *A* is only one half that of elevator *B*. The principal difference between the two elevators is the speed of the belt which for elevator *A* is 250 fpm and gives a centrifugal discharge, whereas, elevator *B* with a belt speed of only 135 fpm has a gravity discharge which allows some of the coal leaving the bucket to fall on the descending buckets and get between the belt and bucket fastenings. The high-speed belt also has sufficient speed to shear off any sticks which might get into the hopper.

The operating labor, given in Table 1, shows an average of 6.7 cents per ton for thirteen plants, which is roughly twice that of the average maintenance cost. The operating costs are more affected by the type of equipment used than appears to be the case with maintenance. Those plants, receiving their coal in hopper-bottom cars and unloading by gravity into a pit, show an operating labor cost varying between 6.1 cents and 10.1 cents per ton and averaging 7.8 cents per ton. Those plants, using grab buckets for unloading either from coal barges or from flat-bottom coal cars, show an operating cost of from 4 cents to 5.3 cents per ton, averaging 4.7 cents per ton. It should be noted that the table does not include any systems using car dumpers or car unloaders which would be expected to have lower operating labor costs, but several plants not listed using car dumpers show total maintenance and operating labor costs varying from 6 cents to 10 cents per ton, which is somewhat lower than the average of 10.6 cents per ton given in Table 1.

The cost of power, which varies from several kilowatthours to a fraction of a kilowatthour per ton of coal handled, and the cost of lubricants have not been included in the operating costs represented in Table 1, but these items are usually small in comparison with the other costs.

FIG. 1 COMBINATION OF BULLDOZER AND CARRYALL FOR HANDLING COAL IN STORAGE

FIXED CHARGES ON COAL-HANDLING EQUIPMENT

It will be noted that the fixed charges, which have arbitrarily been assumed to be 12 per cent per annum on the investment, are considerably in excess of the operating costs in all except three of the stations. The low fixed charges in these three stations of small coal-handling capacity are partly due to their requiring but little equipment for handling coal to and from their emergency storage; but nevertheless it indicates that, depending upon the rapidity of the growth of the plant, it may be more economical to install relatively low-cost, small-capacity, coal-handling equipment for the initial installation which can later be replaced by equipment capable of meeting the requirements of the enlarged or ultimate plant than to design the original coal-handling equipment for the ultimate plant. The usual economic analysis must, however, be supplemented by considerations of the continuity of coal deliveries, reliability, and operating-personnel requirements.

The fixed charges on coal-handling equipment for plants using water-borne coal, received in large lake or ocean-going vessels, are usually high on account of the large-capacity unloading equipment required to avoid payment of demurrage and on account of extensive storage-handling equipment. A large temporary storage must be provided to supply the daily use between delivery periods, and an extensive storage must be provided for closed-navigation periods on the Great Lakes. Most of the coal for such plants must pass through storage and thus be handled twice, with resultant increases in handling costs.

The average of the fixed charges for the fourteen plants listed is 27 cents per ton of coal burned, which is 2.6 times as great as the combined maintenance and operating labor costs of 10.3 cents per ton.

USE OF BULLDOZER AND CARRYALL FINDING FAVOR

The high fixed charges for central-station coal-handling systems are partly due to the extensive storage-handling facilities required. In addition to the temporary coal storage, that must be provided at some plants where the coal delivery is intermittent, practically all stations keep a permanent storage which is usually large enough for several months' supply. It is in this equipment that the greatest reduction in investment can be made. The use of bulldozers and carryalls is finding increased favor for handling storage coal. For short distances, up to approximately 150 ft, the bulldozer by itself may be used economically, while for distances beyond this a carryall in combination with the bulldozer is used, such as is illustrated in Fig. 1.

This equipment has been in use for road building and moving earth for some years, but has only recently been adopted by central stations for the handling of storage coal. The bulldozer consists of a caterpillar tractor with a blade somewhat wider than the tractor and at right angles to the tractor center line, which can be adjusted vertically. The angledozer is similar except that the blade can be set at an angle and also adjusted vertically. The operation of the carryall, which is attached to the bulldozer or angledozer, is controlled by the operator of the tractor and it can load or dump quickly or at a uniform rate as it moves along. The coal-handling capacity of the carryall varies with the size of the equipment and the distance hauled. Thus with a 10-ton-capacity carryall, hauling 300 ft, the handling capacity would be approximately 120 tons per hr. For twice the distance, the capacity would be approximately 90 tons per hour. Records available indicate that the over-all cost of handling coal by this method, including operating labor, maintenance, fuel, lubricants, and depreciation, does not exceed 5 cents per ton.

With the use of the bulldozer and carryall, it is only necessary to provide an initial pile somewhere on the conveying system from which the coal can be moved into storage. The reclaimed coal can be delivered into a hopper feeding onto the plant conveying system. With this equipment, more coal can be stored in a given area, since no encumbrances such as crane or railroad tracks need be provided, and the storage area may be irregular in contour. Additional capacity can readily be provided by additional units at very low cost compared with the conventional methods.

Small bulldozers for compacting coal have been in use for many years. Their action in compacting coal is not by compression alone, since the weight on the treads in contact with the coal is only 6 to 8 psi, but by thoroughly mixing the coal and depositing it in layers 6 in. to 12 in. thick, the fine coal filling the voids between the larger lumps. The effect of simple compression on $1^1/_4$-in. bituminous screenings is shown in Fig. 2. This test was made by subjecting 1 cu ft of coal, confined in an open box, to varying pressures. At a pressure of 1500 psf,

corresponding to the pressure at the bottom of a 30-ft pile of coal, the density was 56.25 lb per cu ft, while the average density was 53.75 lb per cu ft. The density of coal at the bottom of storage piles, placed by drag scraper or clamshell buckets, has been found to be from 58 to 60 lb per cu ft after several years of storage. When the same coal is compacted with bulldozers, the average density throughout the pile will be from 62 to 65 lb per cu ft, and if a carryall is used in conjunction with the bulldozer the density will be increased further.

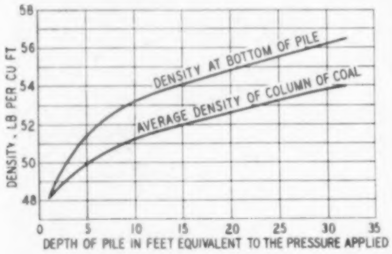


FIG. 2 COMPRESSIVE TESTS ON $1^1/_4$-IN. BITUMINOUS SCREENINGS

It is well established that spontaneous combustion occurs in coal piles if the air circulated through the pile is insufficient to keep it cool but sufficient to support combustion. This condition exists when coal is stored by the usual methods which tend to segregate the coal. Any attempt to compress the pile after it has been built up is futile. Excluding the air by water or by covering the pile is expensive and adds to the difficulty of reclaiming. Some coals are more subject to spontaneous combustion than others, but all kinds of coal have been successfully stored when compacted by bulldozers. It is evident that screenings or crushed coal can be compacted better than sized coal which does not have the fines to fill the voids.

CAR-UNLOADING METHODS

The capacity of the coal-handling equipment when receiving coal by rail is fixed largely by the speed at which cars can be emptied, which again is determined by the size of the coal, by whether it is wet or dry, and by the type of cars. There are some localities in which coal is received in hopper-bottom dump cars only.

Other localities may obtain coal in flat-bottom cars only or in cars of several varieties. A grab bucket is ideal to use for flat-bottom cars, but not for hopper-bottom cars nor for cars with cross braces.

When using a $1^1/_2$-cu-yd grab bucket with a locomotive crane or overhead bridge, a 50-ton flat-bottom car can be unloaded in approximately 20 minutes. Allowing time for switching the cars, the unloading capacity would probably not exceed 100 tons per hr continuously, and one man would be required on the crane and one man in the car.

When dumping free-flowing coal from 70-ton hopper-bottom cars into a pit of ample size and length to dump the entire car at one setting, the average unloading speed including switching will be approximately 200 tons per hour. Fine coal $^3/_8$ in. and less, when wet, will reduce the speed of unloading even with four men in the car to 100 tons per hour or less. If the coal pit is small and only one half the car can be dumped at one time, the unloading time mentioned may be doubled.

The reliable capacity of either of the foregoing methods for unloading screenings of $^3/_8$ in. and smaller, when wet, is approximately the same and is not much in excess of 100 tons per hour. For elevating coal at this capacity, various types of equipment are used such as belts or chains with buckets, skip hoists, and occasionally inclined belts.

Reliable capacities over 100 tons per hour when handling fine screenings, especially when wet, must be obtained by means of car unloaders or car dumpers. A recently developed "accelerator" for unloading hopper-bottom cars is shown in Fig. 3. The dump gates in the car are opened and the accelerator screws are revolved, digging themselves into the coal until the bottom of the car is reached, whereupon the screws are reversed to expedite the flow of coal. With this device two 70-ton cars are unloaded per hour, with one operator and one or two cleanup men in the car, when unloading into a small-capacity track hopper. With a large track hopper, permitting continuous operation of the accelerator, a 70-ton car can be unloaded in 20 minutes. The accelerator is fairly efficient in handling frozen coal, provided the coal surrounding the hopper doors is removed by hand or some other means.

Another type of car unloader which has been in use for several decades consists of an overhead crane carrying heavy spuds approximately the width of the car and a large air-operated jack hammer, as partially shown in Fig. 4. The coal is moved toward the car openings with the spuds after the jackhammer has made openings through tightly packed coal above the car hoppers. The jack hammer is especially valuable in breaking up frozen coal. This equipment can also be used to move cars, which is a decided advantage. With a crew of four men, one operating the unloader, cars are unloaded and shoveled clean at the rate of one 70-ton car every 10 minutes, even with wet $^3/_8$-in. slack.

Capacities greater than those mentioned must be obtained by means of car dumpers which, with two men, will unload coal cars of any size and kind at the rate of one every three or four minutes. Frozen cars of coal present a difficult problem and cannot be handled with the car dumper unless they are previously thawed out or the coal is broken up.

Elevating coal at large capacities is generally accomplished with inclined belts, the cost of which does not increase as rapidly as their carrying capacity increases so that the capacity is determined by the car-unloading speed or other considerations.

For conveying and distributing coal over the bunkers, belts with traveling trippers are very generally used, especially for the larger capacities, although the use of scrapers or flight conveyers is becoming rather common even for large capacities.

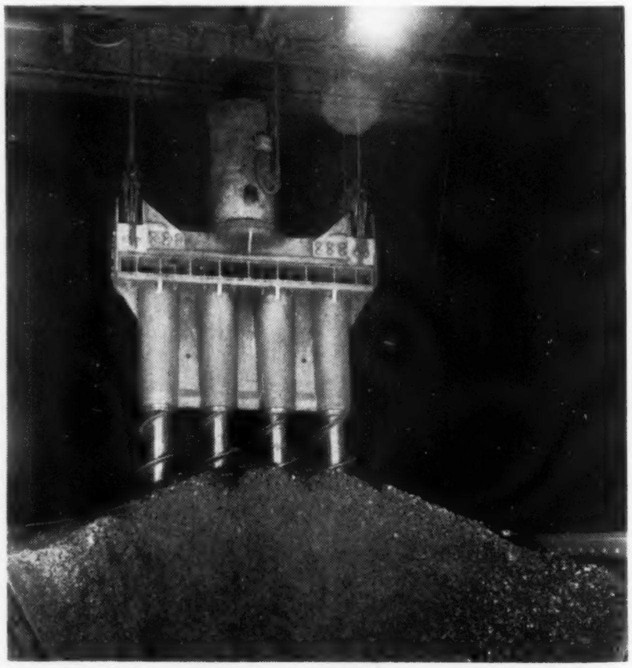


FIG. 3 "ACCELERATOR" FOR SPEEDING UP UNLOADING OF HOPPER-BOTTOM CARS

The use of rivetless chains instead of roller chains for flight conveyers is becoming more prevalent. To obtain roller chains with a strength equal to the rivetless type, it is necessary to select chains, especially for the large capacities, with about 4 times the weight per foot so that the effect of low frictional resistance is lost in the added pull due to the chain weight. The chief maintenance of scraper conveyers is the trough linings which can be designed for easy replacement.

ELIMINATING DUST FROM COAL-HANDLING OPERATIONS

The elimination of dust in coal handling has recently been receiving attention from central-station operators. The practice of The Commonwealth & Southern Corporation Engineering Department in this regard may be of interest. The top of the coal bunkers is sealed with a floor and a slight suction is maintained in the bunkers with an exhaust fan. This not only removes the air displaced by the coal but also induces a flow of air into the bunkers through the conveying system or distributors. A dust collector on the fan discharge was found to be unnecessary on account of the insignificant amount of dust collected. Flight conveyers can readily be totally enclosed, as shown in Fig. 5, which also shows the design developed for accessibility and ease of replacing the trough wearing plates. A design for sealing a traveling distributor is shown in Fig. 6, which has proved entirely satisfactory in practice.

Practically no dust rises from the coal carried on conveyers if protected from strong air currents, except at the loading points or on the return. At the return, an efficient belt scraper is provided, discharging into an enclosed hopper or chute. Loading chutes and coal feeders are provided with dust-tight enclosures. At the discharge end of the chutes where the coal is delivered to a belt or feeder, a slight suction is maintained which effectually keeps the dust from emerging. A small fan and cyclone separator, discharging back into the coal stream, may be provided at each transition point, or a single fan with one or more cyclone separators can be used for several transition points.

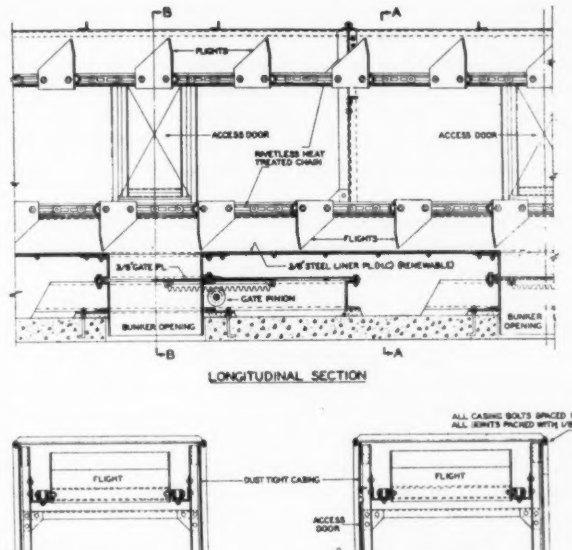


FIG. 5 TYPICAL FLIGHT-CONVEYER SECTIONS

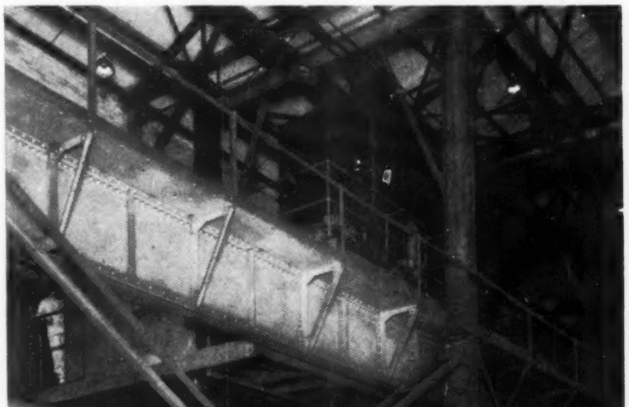


FIG. 4 SPUD-AND-JACKHAMMER SYSTEM OF UNLOADING CARS

With a dust-free coal-conveying system, the top of the bunkers need not be walled off from the boiler room, thus admitting more light and air. In addition, the conveyer galleries, coal pits, crusher room, etc., can more easily be inspected and maintained without discomfort to the operators and janitor labor can be noticeably reduced.

Coal crushers are an important link in any coal-handling system for central stations. With the use of bulldozers for compacting and moving storage coal, it is advisable to be able to crush the coal for storage as well as for the bunkers. Large-capacity nonclogging screens ahead of any crusher serve to prevent the clogging of the crusher when handling wet coal carrying a large amount of fines. Foreign matter such as sticks, iron, or rags continues to be troublesome, except with the Bradford type of coal breaker, which is usually used for large capacities and is finding favor even in capacities as low as 200 tons per hour. Trouble from straw which is used to seal the bottom of coal cars is frequent in some localities. After passing through a Bradford breaker, the straw is well dispersed through the coal, but with the ordinary crusher the straw may be bunched and cause trouble in the plant. The removal of the straw is accomplished in some plants by passing the crushed coal through a coarse-mesh rotating screen.

MOVING AND SPOTTING COAL CARS

The moving and spotting of cars for those plants receiving their coal by rail is a problem that merits careful attention. Much time and labor may be consumed with inadequate facilities and a balance between fixed charges, operating costs, and adequate capacity must be reached. The problem begins with the track layout, including switches, track curvatures, and

grades. The use of a winch for pulling cars is very general but usually it is not entirely satisfactory. If the winch is large enough to pull a string of cars, it is hard on the railroad equipment, and a smaller retrieving winch is necessary to retrieve the heavy pulling cable or an endless cable must be used. To spot the cars over the unloading pit, rail retarders or winch retarders are used or in some plants a block of wood under the car wheels is used.

One utility company makes use of compressed air fed through a hose into the car air tank to spot the cars, which is done by manipulating a three-way cock at the stationary end of the hose. Locomotives of various kinds of motive power are used to switch and spot cars in many plants and for the larger-capacity plants are practically a necessity. One utility company is using a remote-controlled electric locomotive, centralizing the control of moving, spotting, and emptying the cars at the car dumper. This arrangement is reported to be economical and satisfactory. The car unloader and also the accelerator previously mentioned can move and spot cars by lowering the unloading spuds or screws into the car and operating the overhead traveling trolley, which is a decided advantage for this type of equipment.

COAL WEIGHING AND SAMPLING

The weighing of coal going into the plant is general but not universal. Weighing of coal to individual boilers is finding less favor than formerly. There is a great variation in the methods of weighing coal and the location of the scales in central-station practice. In some plants the entire car dumper is on scales, and in others simple track scales are used to weigh the coal into the plant and to check the individual car weights, although it is doubtful whether the latter use can be economically justified. Automatic scales are installed at some transition point in the coal-handling system in many plants, while others use weightometers which weigh the coal as it is conveyed by the belt. Coal scales are usually checked frequently and their accuracy is generally conceded to be high.

Obtaining accurate coal samples is a major problem that has not been generally satisfactorily solved. Much attention has been paid to procuring a representative sample and many ingenious and sometimes complicated devices have been used to obtain a sample over the entire width of the conveyer belt. Since the principal variable in the daily coal supply is the moisture content which may change rapidly on exposure of the sample to the air, it would appear that as much or more attention should be paid to the method of caring for the sample as it is being taken and handled up to the time the moisture determination is made, as is paid to complex methods of getting what are thought to be representative samples.

This paper has covered briefly some of the practices and some of the problems involved in the design of central-station coal-handling systems. If it has directed attention to the necessity of a further study and investigation and the need of careful design of all of the details to provide reliable and economical coal-handling systems for central stations, it will have accomplished its aim.

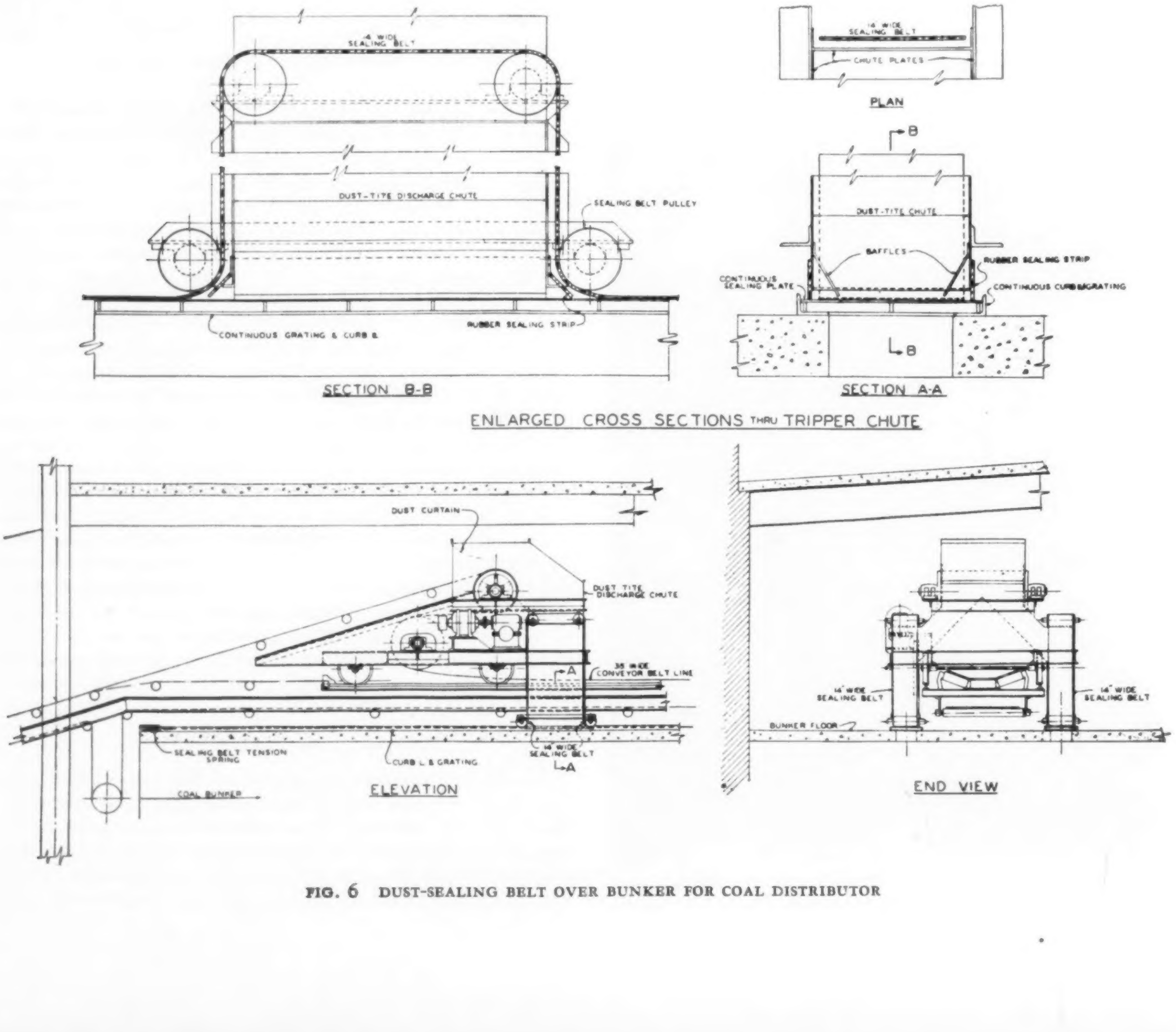


FIG. 6 DUST-SEALING BELT OVER BUNKER FOR COAL DISTRIBUTOR

The Selection of SUBORDINATE PERSONNEL

By HAROLD C. TAYLOR

HAWTHORNE WORKS, WESTERN ELECTRIC COMPANY, CHICAGO, ILL

WE ARE going through a period now when the demand for improved selection methods, along with improved training methods, is doubtless greater than it has been for nearly twenty-five years. Every business and industrial organization needs to hire men who can learn their jobs quickly; who can reach high standards of efficiency on repetitive jobs; who can remain stable under pressures; and above all, men who have whatever it takes to develop rapidly for higher-grade and supervisory positions.

With the selection problem thus looming up with increased importance, it is natural that increased attention should be paid to those procedures which the books on personnel administration have called "scientific selection." It is to these principles of scientific selection that I wish to call attention today. It seems that our attention might most profitably be devoted to these principles for two reasons: First, those employers who have now turned their attention to the possibility of scientific selection are sometimes under the impression that there is some single mysterious formula, some "open sesame," which can be applied more or less without change to any specific employment problem in such a way as to yield immediate and adequate results. Unfortunately, there is no such formula. There are only some techniques and points of view which are helpful in working out improved procedures in a specific situation.

Secondly, it is widely felt that this formula for scientific selection, whatever it is, is unerringly accurate in its power to choose exactly the right man for each and every job—to fit without error square pegs into square holes and round pegs into round holes. It is often believed that the technician in the field of so-called "scientific selection" will be able to accomplish something equivalent to drawing rabbits out of a hat.

Unfortunately, this hope also is much too optimistic. The procedures of scientific selection do make possible a definite improvement in selection of personnel. There is abundant evidence that this is so. But those who hope for miraculous results are due to be disappointed.

You who are here today are largely the men who in your own organizations will determine whether new selective procedures should be installed in your employment offices, and you are the ones who will be called upon to pass judgment upon the worthwhileness of such procedures after they have been tried out. It seems therefore, that a discussion of the principles of and points of view toward these techniques will serve your needs more adequately than any detailed elaboration of procedures.

THREE TECHNIQUES

There are three fairly distinct techniques which require some discussion, these are: (1) The weighted application blank, (2) the planned interview, and (3) employment tests. While we shall devote most of this discussion to an evaluation of tests, these three techniques will be discussed in order.

Contributed by the Management Division and presented at the Semi-Annual Meeting, Kansas City, Mo., June 16–19, 1941, of The American Society of Mechanical Engineers.

1 THE WEIGHTED APPLICATION BLANK

Let us turn then to the "personal-history analysis" or "weighted application blank." The usual application blank covers a good many items of information which can easily be obtained from applicants on paper and in a very short length of time. These are, for example, age, education, marital status, number of dependents, racial background, and perhaps such items as amount of life insurance carried, possession of an automobile, and so on. Many times it would be difficult to give a very clear reason as to why some of these things might bear on the success of applicants in the occupation under consideration. Nevertheless, such items of information are so easily and cheaply obtained that it is often worth while to check them against a group of outstanding employees in the occupation and a group of relatively less successful employees in order to determine whether such items do in fact distinguish between the two groups.

Sometimes this type of analysis is strikingly successful. For example, the Life Insurance Sales Research Bureau has used such techniques in developing a weighted application blank for life-insurance salesmen. They have found that a high group of agents could be chosen with this technique such that their first-year sales volume would be nearly twice as high as average first-year production, and four times the production turned in by the lowest group.

Before adapting such techniques to your own uses in selecting industrial personnel, we would suggest that you look at each tentative item in order to determine whether the people whom you would normally choose for the particular occupation vary to any great extent with respect to that item. For example, your obvious job requirements and your labor supply may be such that the age range, the educational level, and the racial stock of potential employees may be quite uniform. In that case, there is not much point in studying intensively the minor variations of applicants in these respects.

2 THE PLANNED INTERVIEW

The planned interview is based upon one fundamental principle: That the best indication of what a man will do is what he has done; or that the kind of person a man has been is very much the kind of person he will continue to be. In everyday life among our friends and business associates, this is the basis upon which we guide our actions toward them. A wife learns to detect the precise moment at which her husband will be reminded of his favorite story. Men learn with considerable precision at what hour of the day the boss can best be approached, what words to use in obtaining his approval, and so on. This type of prediction does not necessarily involve knowledge of psychological theories on the part of any of us. It involves only a recognition of the fact that, generally speaking, people do not change. Throughout a considerable variety of environmental situations they will continue to act according to their habits.

To some extent, employment interviewers have always made

use of this principle. We regard it as significant if we discover that a man has held one job for as long as three years, simply because that fact offers at least a shred of evidence of his job stability. If he has held twenty jobs in the last three years, we regard that as some indication that he will continue, for whatever unknown reasons, to flit from one job to another. The planned interview is simply a term to describe a more conscious, more systematic, and more enlightened direction of the interview toward the objective of discovering and interpreting the significant aspects of what a man has thought, what he has been like, and what he has done. Too many interviews include aimless discussions of the weather, the foreign situation, or yesterday's ball game. The things we should be looking for are those recurrent forms of behavior which the applicant has shown, time after time, which we may take as evidences of what he will be likely to do tomorrow and next year.

The most obvious problem which will occur to you, we suppose, is that the conduct of such an interview does take time and that there is a problem as to whether the devotion of so much time to the selection of unskilled factory personnel, for example, could be justified. In this connection, one cannot help feeling that since a man on the pay roll usually represents a rather sizable investment on the part of the company, the devotion of another hour or two of time before he is placed on the pay roll might easily be defended. However, what should be emphasized most just now is the importance of conducting the present interview along planned and organized channels rather than haphazardly. It is entirely possible that more improvement in selection could be made through some effort along this line than is likely to be made by the use of any other employment techniques. The employment interviewer's judgment carries very heavy weight in the final choice of personnel, and no doubt should continue to carry heavy weight. Anything which can be done to sharpen that judgment should be very much worth while.

This topic deserves a session in itself, but we think that the principles of the planned interview are so obvious, once they are pointed out, that they will be readily acceptable to all of you. We should, therefore, like to turn to another selection technique which is subject, perhaps, to more misunderstanding. This is the employment or "psychological" test.

3 THE EMPLOYMENT TEST

All would agree that the best test of performance is the test of life itself. The only sure way of determining whether an individual will succeed to any specified degree in performing a job is to place him on that job and see how he turns out. No one should pretend that there is any other infallible method of determining whether or not people can succeed in any given vocation.

But this, of course, is a very costly and time-consuming procedure. From the standpoint of the individual, there is a limit to the number of vocations he could possibly try out in such a manner. From the standpoint of an organization which desires to have its work done as effectively as possible, the procedure of tryout on the job is expensive, both from the standpoint of training, and from the standpoint of the effectiveness with which the job gets done.

A "test" is simply a quick way of finding out, as well as we can, what the results of a job tryout would have been. In this respect, a test can be thought of as analogous to the "test sets" used in the inspection of raw materials and industrial products. A complicated machine (the applicant) is delivered to the door of the employment office for potential use in the performance of some function. Various sorts of meters (tests) are applied to this complicated machine in order to make an estimate of the probable effectiveness of that machine in performing the function to which it is to be assigned. It may be useful, because of your familiarity with inspection tests in engineering work, to carry this analogy with employment tests a bit further.

It is the job of the test technician to devise these "inspection-test sets" in such a way that the results of the inspection will yield a larger proportion of effective product than would be the case if those test sets were not used.

Reliability and Validity of Tests

The test technician sets up two main requirements for his test sets: That they must be reliable and that they must be valid. These requirements are not mysterious at all. They are the same as the requirements which would be demanded of any meter or measuring device in the engineering field. Reliability means simply that if you apply the test set twice to the same machine, the reading must be substantially the same. We are all familiar with the fact that some measuring devices, particularly rough methods of arriving at quick approximations, will give results that vary slightly from time to time. In other words, the "reliability" of such meters in any field is not perfect. In other fields we may often get around this difficulty by taking several readings. This is exactly the procedure often used in giving psychological tests. If one reading is not accurate enough, we take additional readings. This means giving the same test again, or giving other tests of comparable type.

The second requirement of a test in any field is that it must be valid. This means simply that readings on this meter must be related to the effectiveness of the material which is being tested. This concept, also, is common in the engineering field. For example, thorough and precise methods may be worked out for the testing of some characteristic of a material or product in the scientific laboratory. This thorough and highly precise test is likely to be costly and time-consuming. The engineering problem, then, can be stated as one of developing some quick and inexpensive way of arriving at somewhere near the same result. In soap cooking, for example, there are precise methods of determining in the laboratory whether or not a kettle of soap has cooked long enough. However, if one waited for the results of such an analysis, the kettle of soap would already have cooked too long. Consequently, the soap cooker has to learn to tell by feeling and tasting the soap when it has cooked long enough. In this case, the extent to which the soap cooker can make the same decision every time under comparable circumstances is his reliability. The extent to which his decisions are right is his validity.

In the case of the employment testing of candidates for positions, the chemical-laboratory test which we wish to approximate is the test of life itself in that vocation. The problem is to develop some shorter way of approximating as well as we can the results of that test.

There are, thus, many points of similarity between the construction of a device for inspecting human material and the construction of a device for inspecting any other type of material. The technical skill of the technician who is engaged in this work does not consist in any mysterious mind-reading capacity which some persons think he has and which others insist he does not have. He is engaged in the making of devices which are much more comparable in principle to an electric meter or a chronometer than they are to a crystal ball or a divining rod.

How Valid Are Tests?

There is one important distinction which needs to be made between the meters with which most of you as engineers are familiar and these meters or tests which are used in the prediction of the future performance of human beings. The meters that most of you use in your engineering work are highly

valid—that is, they predict with considerable accuracy the future performance of the devices you are testing. On the other hand, the meters which we use in gaging the potential future performance of human beings do not predict that performance with anything like the accuracy to which you are accustomed. Generally speaking, it will happen with any test or any series of tests used in predicting human performance that a few persons who do poorly on the tests will turn out well on the job if given a chance. Even more often, it may happen that some who do well on the tests will be found not to succeed in the test of life itself.

There is no doubt that this difference between the predictive power of mechanical, chemical, or electrical tests, and the predictive power of psychological tests has led some engineers to become doubtful of the value of psychological tests. They are accustomed to working with tests of such high precision that the relatively low predictive power of psychological tests leaves them disappointed with the usefulness of such devices.

Three Reasons for Relatively Low Validity of Employment Tests

There are three very good reasons, I believe, for this sharp difference in predictive power. The first of these is that a good many of the factors which determine what is going to happen to an individual in months and years to come are not inside his skin at all. They are environmental factors which may vary from those he has previously met in ways which we cannot at all foresee. His wife may die, his children may cause him trouble, he may work for a boss who affects him adversely, or his health may change markedly. All of these unpredictable factors will affect his future, as well as those factors inside his skin, to which we are confined when we attempt to test him in any manner and predict his future.

The second reason why the predictive power of psychological tests is less than that of mechanical or electrical tests is that in testing mechanical or electrical devices, we are ordinarily concerned very directly with the extent to which the device performs at the moment in the manner in which it was intended to perform. We do not have to make any very far-reaching inferences from its ability to perform in a certain manner to anything about the future ability of the device to perform in some other way. The testing of mechanical or electrical devices thus approaches what we call "proficiency testing" or "trade testing" in the inspection of human materials. For example, if a girl says she can type at a certain speed, we can test her possession of that skill with a high degree of accuracy. If she says she can take dictation accurately at certain speeds, her skill can also be tested with considerable accuracy.

By contrast, however, it will be noted that in most psychological testing, the person being tested cannot perform at all the functions for which we wish to test him. We are always in the position of inferring from the present behavior of the individual on certain tasks what his future performance will be on other tasks which he cannot now do. Sometimes these other tasks in which we wish him to achieve proficiency differ markedly from anything he can do now. Under those circumstances, of course, it is not easy to determine with assurance what aspects of his present performance may serve as reasonable clues to his future behavior. This longer-range forecasting of potential future performance on untried tasks is called "aptitude testing," and constitutes most of what you think of as employment testing.

There is a third reason why tests of human future performance are not as valid as most tests of mechanical devices. This is that the factors within a man's skin which make for his success in any activity as complicated as success on a job are large in number and complex in their interrelationships. We cannot hope to cover in our testing of the raw material which stands before us as a potential candidate all or even a high proportion of the factors within him which will influence the degree of his success or failure. Out of the multitude of such factors which in reality bear upon his future, we can test only those which we have been able to identify as being of substantial importance; and even among those, we can test only the ones we have learned how to test with some degree of accuracy.

Tests Do Improve Our "Batting Average"

Thus it is that the engineer is bound to be disappointed with the results of psychological tests if he expects to find the precision to which he is accustomed in his own work. It seems to us, however, that when he is faced with the results of psychological tests, he should not infer therefrom that the tests are no good. He is faced, in reality, simply with new evidence of what he has known all the time, namely, that the human being is a highly complicated machine as it stands, made up as it is out of the interrelationships of countless hereditary factors and innumerable experiences. Thus the prediction of the individual's success in some untried field as he meets further unpredictable environmental factors is a difficult job.

Nevertheless, the making of those predictions, however difficult they may be, is a job which we cannot escape. Employment men are making such predictions every day, and so are line supervisors who accept or reject candidates submitted by the employment office. Tests must be evaluated simply upon the basis of whether they improve our present practice in making these inevitable decisions—not on the basis that they fall short of perfection.

There is an abundance of evidence that, looked at in this modest way, tests do improve our batting average in selecting the right man for the job. From the technical and professional journals in this field, we doubt that it would be any trick at all to accumulate a five-foot shelf of literature containing nothing but evidence of the substantial, though not miraculous, contribution which tests have made in various business and industrial situations in the selection of personnel. Although it might be dramatic for us to quote some of this evidence, and might lend conviction to our statements, we feel, as indicated at the outset, that a statement of principles and points of view toward tests is all we can hope to cover at this time. It has been our experience that most of the confusion which exists concerning the usefulness of tests is due to the fact that these basic considerations have not been kept sufficiently in mind.

Those of you who wish to investigate further the evidence concerning the usefulness of tests, and who wish to know more about specific tests which may be of use in your own organizations, will be interested in looking over a recent report by Dr. Herbert Moore, entitled "Experience With Employment Tests," and published by the National Industrial Conference Board last March. For the moment, we should like simply to offer a few comments concerning the pitfalls into which those who first undertake the use of tests sometimes fall.

Some Cautions in the Use of Tests

1 Don't expect too much from tests. Keep in mind that tests will not bring about perfection in the complicated job of selecting people. They will serve only to improve the batting average.

2 Don't allow the use of tests to relax your present employment procedures, which give heavy consideration to the judgment of the experienced employment interviewer. The employment man should not be made to reject a candidate who looks good to him, simply because that candidate made a low score on the tests. The converse of this is even more true; don't accept for employment a man who doesn't look good to you,

just because he made a high score on some test. Ideally, a man should be hired only when all of the criteria for selection are favorable.

3 If you decide to go into the testing of employees, don't devote too much time to the invention of fancy-looking gadgets. The invention of a shiny new manipulative, assembly, or coordination test has been a favorite pastime of newcomers in the testing field for a long time. The development of such apparatus tests is laborious and expensive, even when done by an expert. Usually they are expensive to give and to score. When not developed by an expert, they are often also weak in the two essentials of any measuring device—reliability and validity. It is much better to make a fairly good choice from among those tests which have already been developed and used under circumstances which appear to be comparable to your own.

4 Don't get involved in the use of a large number of tests in your employment office. If you pick tests for each occupation with which you are concerned, strictly on the basis of the ideal setup for that occupation and without regard for your over-all employment picture, you may wind up with such a large number of tests which have to be given to the applicant that the program bogs down and takes an inordinate amount of time. Fortunately, it is usually possible to get along with a relatively small number of broad-purpose tests without a great deal of loss of effectiveness in predicting for any one occupation. If one chooses two or three fairly good tests for one occupation, it usually happens that the addition of other tests, no matter how relevant they may appear to be, will not make much added contribution to your predictive power. Successive tests after the fourth or fifth, at least, usually yield very small additional returns.

5 Don't give much thought to the use of tests in occupations where your hiring volume is very small. Tests offer their greatest potentialities under conditions of fairly heavy volume.

6 Don't try to install a test program without technical assistance from someone who has had experience in that field. I don't mean that there is anything esoteric about making tests work. But there is, after all, a considerable body of technical literature in the field on which one should capitalize in lining up his own program. There are special statistical techniques which are not exactly the same as those commonly used in solving business or engineering problems. And there are matters of interpretation of test results, on which one may easily go astray.

Can Tests Be Put to Use on Short Notice?

With regard to this whole problem of the usefulness of tests to you in your present hiring emergency, we know that many of you are thinking that the installation of tests in your employment office represents a slow and expensive proposition. Your present problem, it is recognized, is not one of making long-range plans for the future, but of doing as well as possible the hiring job which must be done right now. Is it possible to short-circuit in any way the rigorous process of tryout and calibration of tests, so as to make them more or less immediately available to you for your present needs?

We are personally convinced that it is possible for the test technician to offer you such immediate help in the selection of personnel for most of your larger-volume occupations. We must emphasize, by way of qualifying this point, that there are relatively few test technicians in the country today who will offer you such immediate help; and we are afraid that some of those who are most eager to do so may tend to be among the less experienced men in the field.

There are a number of good reasons why competent professional men in this field tend to be unwilling to do what they can for you without thorough scientific experimentation. We have not the time to go into those reasons in detail, but there is one which seems to us to be worth calling your attention to.

Let us bear in mind that when the test technician has finished his job of "calibration," he has obtained proof that the results of his tests do actually check with the ultimate test of life—that is, with success in the vocation for which he is predicting. That proof is essential from a standpoint which is very important to a technician in any profit enterprise: A demonstration that one's efforts have been worth something in a competitive, cost-minded world.

In the absence of such rigorous proof, it is very easy for those who are a bit skeptical concerning the usefulness of tests to conclude after a time that the program has not been worth while. For one thing, they see only the employees you actually got on the pay roll with the help of tests. They have no idea what those potential employees might have been like who would have been hired if the tests had not been used. Also, the employees whom you hire may be scattered over a broad territory, such that no individual supervisor has intimate contact with a very large proportion of them, so as to be able to arrive at any justifiable opinion about the adequacy of the selective process. Furthermore, the differences between good and less good employees do not show up overnight, but may be in question for a year or more while the new employee is finding his niche, and gradually coming to be recognized in terms of his true job competence. And finally, as we have said, the improvement in selection will not be dramatic and startling, as it might be if we could offer the prospective employer a crystal ball.

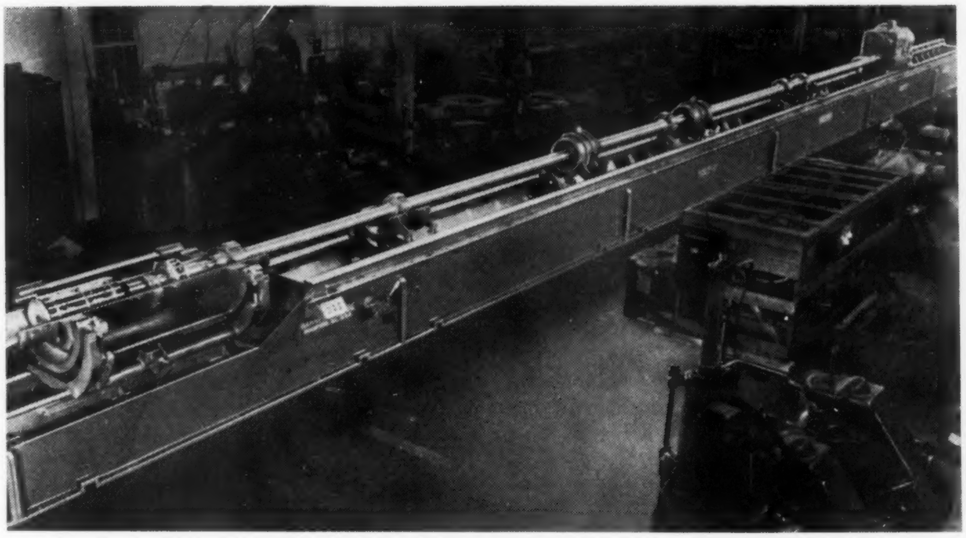
Therefore, while we are personally convinced that tests can be of immediate use to you in many of your employment situations, nevertheless, if you want to use tests on that basis, you will have to accept them on faith, and you will have to assure the technical man who helps you that you are prepared to make use of them on that basis. Most experienced test technicians have had their fingers burned often enough by skeptics to be very conservative, unless you can give them reassurance of your fundamental appreciation of what you are asking them to do.

SUMMARY

We have now covered in a general way the basic principles of three of the techniques of so-called "scientific selection"—the weighted application blank, the planned interview, and the employment test. Some detail has been presented concerning certain aspects of these techniques; but it is really a point of view that we have been attempting to convey, rather than a mass of detail, and by way of summary, that point of view may be briefly restated.

That point of view is that the application of scientific principles to selecting people must be approached in exactly the same way that you approach your everyday engineering problems. You don't expect to perform magic; you don't have a wand that will build bridges, or a secret incantation that will bring out of the air the perfect way to process a new plastic.

You do have a set of principles and methods, and a body of technical knowledge; and you use them to do the job a little better today than it was done yesterday, and a little better again tomorrow. Looked at in this light, the selection techniques we have discussed today are useful in improving our batting average in the selection of employees; and they can be put to use in the present period of rapid force expansion.



HORIZONTAL HYDRAULICALLY RECIPROCATED HONING MACHINE HAVING 76-FT SPINDLE STROKE

(Capable of honing 30-in. diameters; this view shows 14-in. diameter hydraulically operated honing tool mounted on the end of the long intermediate driver; over-all length of machine, including work-support bed, 184 ft, 2 in.; total weight as shown, 91,130 lb.)

The HONING PROCESS *in* NATIONAL DEFENSE

By A. M. JOHNSON

PRESIDENT, BARNES DRILL CO., ROCKFORD, ILL.

TO a great many manufacturing companies who have taken defense orders, the honing process has been unfamiliar, and although their peacetime products required it, war machines added particular problems to the art. The mechanical idea of the process has been used for many years, but only during the last fifteen has that idea been developed into a commercial process.

Machines and tools began to appear about 1925 and have undergone a development probably not equaled by any other machining process. The remarkable results now obtained are due to the great amount of experimental work done by the machine and tool manufacturers.

Honing is utilized in a wide variety of manufacturing processes, and has been commonly thought of in connection with final finishing of cast-iron cylinders. However, with the development of improved machines, tools, and abrasives, it became possible to hone soft as well as hardened steels of the various alloys. With the development of the airplane engine came first the honing of cylinders and then the finishing of various bearings and pinholes, such as crank- and piston-pinholes of radial-engine main rods. It was found also highly advantageous to hone the articulating-rod pinholes in the main rod, as damaging scratches were removed and practically a 100 per cent bearing afforded the pin maximum bearing area. Formerly the burden was put upon the hone of producing the hole accurate in diameter, round, and free from taper. With the coming of the radial engine with aluminum heads shrunk on steel cylinders, a requirement in some cases was for a finish-honed bore several thousandths smaller at the head or blind end to allow for greater expansion at that point. This result has been accomplished by special honing tools together with proper technique in machine operation.

Presented at the National Defense Meeting, St. Louis, Mo., Sept. 9–11, 1941, of The American Society of Mechanical Engineers.

There are many other parts, such as propeller hubs and shaft extensions in some cases, where accurate fits are required and others where it becomes necessary to have the holes free of scratches, which scratches might cause fractures to develop. This is true in the case of the accessory drive shaft about four feet long having a $^3/_4$-in. hole three quarters of its length and the remainder $^7/_8$ in. Fractures of this shaft which occurred when the hole was reamed were reduced to zero after the honing process was adopted.

Honing has made possible the proper functioning of the landing gear of airplanes. The shock cylinders as well as those needed for retracting the landing gear and many other cylinders for operating various devices of a warplane are now being honed.

It frequently becomes necessary to hone to the bottom of a blind hole or to a shoulder. In these cases it is the practice to leave slight recesses at the bottom when performing the previous machining operations. By the use of a special hone and by having the machine equipped with a mechanism for positive stopping and timed dwelling, a uniform diameter can be produced.

Vertical machines are much more convenient to operate than

horizontals, and should be used where work is not too long. Verticals have been built with a stroke of 8 ft to hone work up to 30 in. diameter. One such machine was 32 ft high and was equipped with a hydraulically operated in-and-out table in order to afford ease of loading as well as convenience of gaging.

Smaller machines cover the field down to a minimum diameter for which honing tools can be practically made—about $^5/_{16}$ in. Horizontal machines are used extensively for honing cannon from 20 mm diameter up to the largest naval guns. Machines having a stroke of 75 ft have been built for honing work up to 30 in. diameter.

Recuperator cylinders require a high degree of accuracy and finish. It is necessary to hone certain types with a motion parallel to the axis and nonrotating except at ends of stroke. This is termed codirectional honing. The object is to change the microscopic cross-hatch lines into lines parallel with piston travel.

It is necessary to have accurate diameters and fine finishes on piston rods for recoil and recuperator cylinders. Here again the honing process produces the desired results. For this purpose the work to be externally honed is rotated between centers which are reciprocated on a long carriage with the hone mounted on a floating support attached to the machine frame. When it becomes necessary to produce a codirectional finish, the hone is mounted on a lightweight carriage to facilitate rapid reciprocation and the piston rod is held between stationary centers and rotated a few degrees at the end of each stroke.

Honing of gun bores has proved a very advantageous process, both in the time required for finishing and in the elimination of the hazard present with the finish-boring method. Added to this great advantage are those of smoothness and accuracy.

Ordinarily about 0.040 in. in the diameter is left for the finish-boring operation. When the honing process is employed, a lesser amount can be left for the final finish with practically no likelihood of scoring the tube to a depth such that the honing will not remove the score marks. Honing up to the finish diameter leaves a smooth finish free from sometimes fatally damaging scratches and an accurate finish within very close tolerances.

Most honing tools of the present day are expanded by hydraulic means. In the machine is built a mechanism for performing this function as well as for controlling the rate of expansion. This rate is timed to the enlargement of the honed hole and to the wearing down of the abrasive sticks.

The important requisites of a honing machine are ruggedness and sufficient power, uniform rate of travel, extremely rapid deceleration and acceleration at the ends of the stroke, convenient fixtures for holding the work, and ample quantities of a proper coolant well filtered.

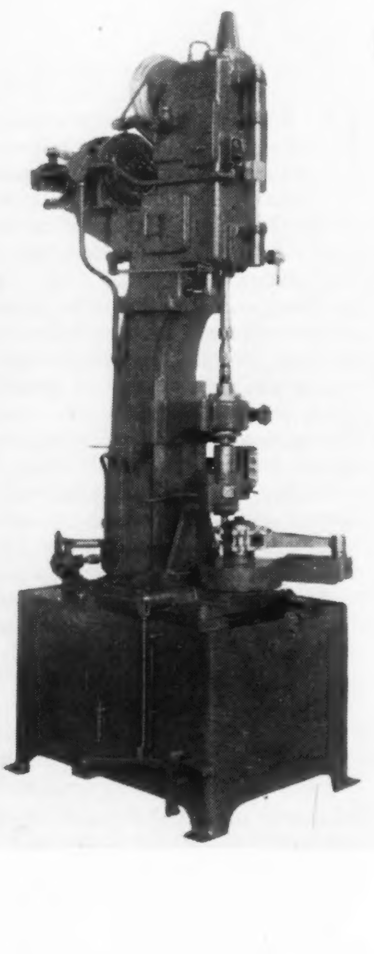
First, the machine must have sufficient stiffness in its frame, and, even more important, its rotation driving train, including gears, shaft, and spindle, must resist any tendency to set up torsional vibration. It is advantageous, especially when honing large diameters, to make the hone with weight enough to produce a flywheel effect, thus aiding the machine in producing a steady, vibrationless, rotary motion to the honing sticks and

LEFT—LARGE VERTICAL HONING MACHINE

(Machine has 90 in. of spindle travel, is 31 ft, 4 in. high, over-all; as here shown. Job being honed is $17^1/_2$ in. diam Diesel-engine sleeve 5 ft long. The machine here shown has 30 hp motor for driving, 15 hp motor for hydraulic pump, each motor, 1200 rpm. Net weight 24,000 lb.)

RIGHT—SIDE VIEW OF HYDRAULICALLY RECIPROCATED HONOR

(Has three-speed V-belt drive. Fixture is designed to take care of eight sets of knuckle pinholes all on different radii but indexing plunger exactly locates each particular set of holes under center line of automatic hone. Crank-operated clamp then holds fixture securely in working position.)



affording better cutting conditions and longer life to the abrasives.

Second, the machine must have sufficient power to drive the hone under varying conditions of roughing different materials both soft and hardened. Obviously, the abrasive-stick pressure against the wall is a measure of the power which is required. This is generally proportional to the abrasive area acting on the surface times the rotating speed in feet per minute.

Third, the rapid deceleration and acceleration at the ends of the stroke are important in preventing enlarged diameters at ends of holes. Also a quick reversal of reciprocation appreciably increases production as more passages of the abrasives can be made over the surface per unit of time.

The rate of reciprocation varies from 30 to 250 ft per min, depending upon the material, revolutions per minute, and diameter of hone. The cutting speed varies in surface feet from 100 to 225 ft per min, again depending upon the kind and hardness of material.

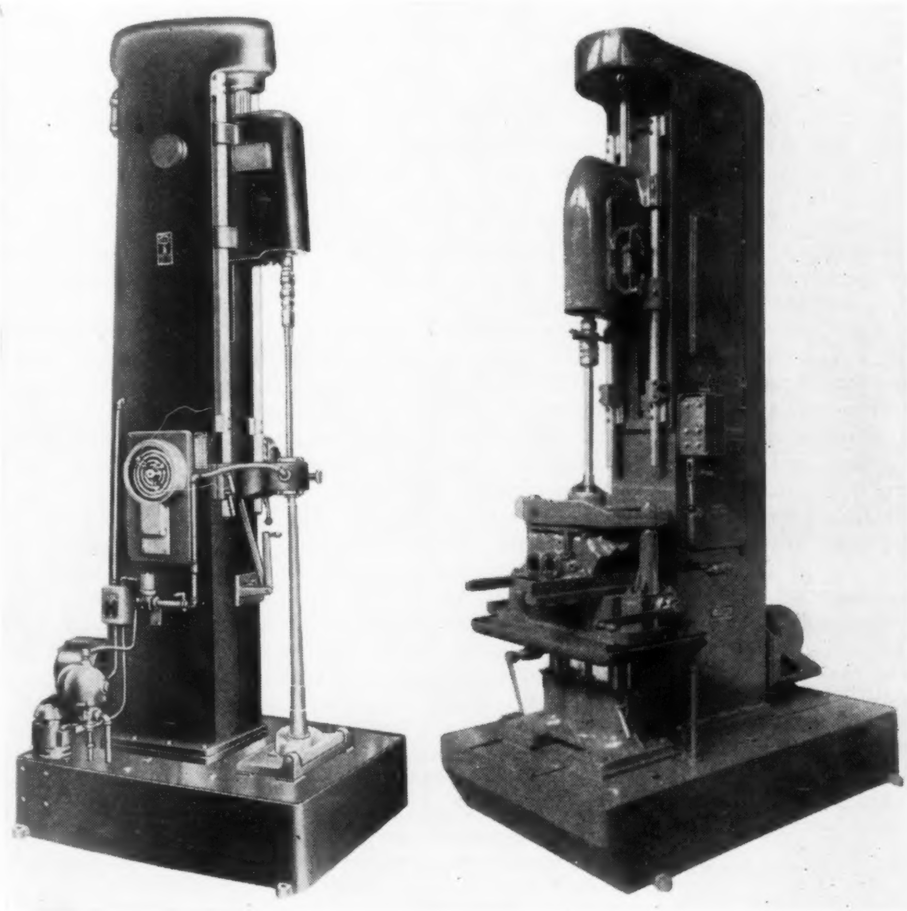
It is necessary to have a copious supply of clean coolant delivered to the hone to carry away the minute particles of material removed from the walls and to keep the abrasive sticks in a free cutting condition.

There are several recommended kinds of coolant. Kerosene is used for honing cast iron and is used in connection with many other compounds. When honing soft steels, it is necessary to use a coolant which will prevent the particles of steel from embedding themselves in the surfaces of the sticks, thus causing scores and scratches in the surface. To prevent this condition a lubricant must be added. There are several on the market for this purpose under various trade names. One of the commonly used coolants on difficult jobs is a compound of oleic acid, turpentine, and kerosene. Another is pure lard oil with certain percentages of kerosene.

The question probably foremost in most minds is: How fast can a hole be enlarged by the honing processes?

This is a difficult question to answer with any great degree of certainty, as the conditions and kinds and hardnesses of materials affect the honing time greatly. In general, probably good yardsticks would be the results shown in the following experiences: A gun tube 5 in. in diameter and 23 ft long can be honed at the rate of about 0.014 in. from the diameter per hour. From a gun tube 90 mm by $13^1/_2$ ft long 0.018 in. of stock was removed in one and one-half hours. A gun tube 20 mm by 6 ft long was honed, removing 0.006 in. of stock at the rate of three pieces per hour. From a recuperator cylinder 52 in. long, $4^1/_2$ in. in diameter, 0.050 in. of stock was removed in 45 min.

The time required to hone a certain piece is dependent upon the accuracy and amount of stock left by the preceding operation, upon the kind and hardness of the material upon the tolerance allowed, and upon the fineness of the finish required. Generally, the honing process is not a difficult one, but at the beginning of a job, considerable care should be given to the proper speeds, both rotating and reciprocating, to the intelligent choice of abrasive sticks, and to the best coolant for that particular material. If these conditions are satisfied reasonably well, no trouble should be experienced in producing surfaces, both internal and external, conforming to close tolerances of size and finish.



LEFT—DEEP-HOLE HONING OF SMALL, LONG BORES ON VERTICAL HONING MACHINE WITH HYDRAULICALLY RECIPROCATED SPINDLE

(Machine as shown has high column and lengthened spindle travel for honing small bores $^1/_2$ in. diam, and larger, such as tubes, rifle bores, shotgun barrels.)

RIGHT—FRONT VIEW OF SINGLE-SPINDLE HYDRAULICALLY RECIPROCATED HONING MACHINE

(Arranged with 16 in. spindle travel, rectangular independent table with raising screws, a mechanism for dwelling at bottom of stroke. Note special fixture for honing 2.4995 in. ID × $1^7/_8$ in. long bore in supercharger assembly for radial-type aircraft engine.)

ENGINEERS IN POSTWAR PLANNING

By A. M. SELVEY

CHAIRMAN, DETROIT SECTION A.S.M.E.

THE American Society of Mechanical Engineers in January, 1941, published a paper titled "Through a Glass, Darkly," by W. L. Batt, past-president A.S.M.E. and one of the directors of OPM, in which the author said, "It seems to me essential that we immediately create a small group of the ablest men in the country to be set off in a corner by themselves to work now on the preparation of an industrial demobilization plan." The Council of the Society felt that Mr. Batt's message was sufficiently important that the matter should be brought to the attention of all local-section officers and that they be asked to organize local committees and to take part in placing some project on an active basis. Such a project, it would seem, could be handled more effectively in Detroit by an organization embracing not only A.S.M.E. but the Detroit branches of many other engineering societies. The Engineering Society of Detroit is this organization, and under Article IIc of its Articles of Incorporation is authorized to undertake this type of project. For this reason, I welcome the opportunity to present here some ideas concerning Mr. Batt's proposal in the hope that the E.S.D. will undertake the guidance of an activity in this area.

Just why we as individuals or as professional engineers should be interested in this project is described in a Society communication[1] from which I should like to give a few thoughts.

Perhaps we fail to realize that to win a war we must do more than secure a mere military victory. Other victories must be achieved on other fronts. If this is a total war—and events continue to pile up indicating that it is—it must be fought on a total front, not alone on the military one.

It is a mistake to think that some of the broader aspects connected with this conflict can await postwar solution. They are vitally a part of the war itself, as important to success as the purely military phase. History shows that in many cases the important part of a victory, that is the stable part, depends not upon military success alone but on other phases too. Strikingly enough, these particular phases of conflict, which we have relegated to what we are pleased to term a "postwar" position, are all existent in the military one but will progressively assume an increasingly greater importance as time passes.

It might be conceived that this war has a preparedness, a military, an economic, a financial, a social, and a cultural phase. All these exist now to some extent in the present preparedness stage, but they will eventually assume a preponderance which will vary as circumstances change. We can recognize the existence of these phases in our present-day problem, and as we face them all, they must be solved. If we are to win this war, we must win each one of these phases to obtain a permanent victory. We cannot afford to suffer defeat either economically, financially, socially, or culturally.

So far as the United States of America is concerned, the objective of this present conflict is to retain our economic and social structure and, in so far as many of us are concerned, to retain the material and spiritual values which we now hold. At this very moment, all of these things are under fire. Every one of them is in some way being attacked on some front, and they must be defended. To win that particular part of the conflict which directly affects these values requires thought, planning, time, and tremendous effort, as much, perhaps, as is required in the phase of defense preparation. If, in winning a military victory, we sacrifice the social, economic, financial, and cultural ideals, we lose the war. The defense of these ideals is the very essence of the war itself because they are what we fight for. They are important at the moment and will increasingly demand more and more of our time. Characteristic of all wars, a military victory fails to secure lasting peace. It would seem foolish to assume that the construction of material machines of war alone and their operation for the destruction of human life are enough to determine the development and culture of a nation. Only by a consideration of the entire problem shall we be able to secure a complete victory. This premise would appear to be simple; yet it seems to be not generally appreciated.

Specifically, this is the proposal of The American Society of Mechanical Engineers: That engineers, being particularly competent in those important matters of design, production, supervision, and distribution, and being equally interested with all people in the economic, financial, social, cultural, and spiritual phases, take the responsibility of exploring, examining, stating, and publicizing the total problem that faces us in terms understandable not only to us as engineers but to the American people. It should be clearly understood that any plan which may be originated to solve this problem must be founded first upon a full and complete knowledge of its nature, and second upon an elaboration and interpretation of its technical aspects in terms understandable to everyone.

Members of this Society possess a power of analysis superior to the average. They hold a reasonably high place in the life of this city, and are more intimately interested in the Defense Program than perhaps any other professional group. It would seem not only fitting but highly proper and desirable that they should, through an executive council, crystallize and focus the attention of the public upon winning the conflict as a whole. It is to the understanding of this problem, to its interpretation for us in America, to the exploration of it, that we should first address ourselves.

In connection with the suggestion that the Detroit Section A.S.M.E. organize some activity to meet the wishes of the Council, I have discussed our problems with several Detroit engineers who have kindly expressed their individual and personal viewpoints. It is the consensus of opinion, that the solution of this problem, or at least an attack on this problem, could most fittingly be a joint activity of all local engineers through their corporate organization, The Engineering Society of Detroit, and its Affiliate Council. It was further suggested that support for this activity should not be limited to engineers, but should embrace the best minds in the city and state on economics, agriculture, sociology, labor, management, and government, and should obtain effective sponsorship of whatever federal and state authorities are contemplated or are in being.

A federal authority has already been in action under sponsorship of the National Resources Planning Board, with Luther Gulick, Columbia University professor, as chairman. A billion-dollar project under Floyd S. Benjamin, state director of the Public Work Reserve Program, is also being proposed. Of this amount Detroit is asking for over half-a-billion dollars. Characteristic of most government projects, the two mentioned

(*Continued on page 816*)

[1] A memorandum prepared by Allan R. Cullimore, chairman, A.S.M.E. Committee on Civic Responsibilities, which was mimeographed and distributed to all of the Local Sections of the Society.

An address delivered before the Board of the Engineering Society of Detroit, Detroit, Mich., Sept. 23, 1941.

SPENDING OUR WAY TO PROSPERITY[1]

By HORACE C. BUXTON, JR.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

GIVEN one slump, which may sour into a depression unless an antidote is rushed quickly, what do you recommend? Villard would say, "Spend, government, spend."[2]

In the nightmare of depressing events which comprise the slump, certain characteristics stand out as basic elements contributing to the decline of business activity and national income. First, businessmen are not investing in capital replacement or expansion, because they are uncertain about the chance for future profits. Secondly, capitalists are hoarding the surplus funds which they formerly invested, because they either fear loss of principal, or expect a bigger gain by investing later after interest rates have risen again; thus, even when businessmen do seek capital, they have difficulty in finding it. Both these elements tend to cut investment appreciably. But if investment falls, employment declines in the capital-goods industries, the newly unemployed spend less, and the spiral down in national income and business activity has begun.

Though business activity eventually revives under the stimulation of new inventions luring hoarded capital into investment and the depreciation of old plant and equipment requiring new capital for replacement, Villard recommends that the upturn might be speeded if the government gives the economy a shot of cash in the arm, since more cash used to employ more men to produce more goods will necessarily raise national real and money income again. But experience indicates that merely creating more cash and pumping it into circulation does no good, if the cash immediately goes to savers who build bigger and better hoards; so Villard suggests that the government might better pry loose some of the hoarded funds and invest them in human and public welfare to replace the decline in private investment.

The process must not end here, for the government cannot expect to pump into the income pool as much as the slump drains. Nor would it end here. If the expenditure recipients respend most of their new income immediately and thus create a demand for consumer goods strong enough to revive the industrialist's hope for future profits, the latter will invest in replacement and expansion, and thus generate the real recovery which creates an added demand for his product.

As depression-period revenues will not provide all the funds necessary to fulfill the plan, it will require "deficit spending." Certain dangers are inherent in such a program unless it is carefully handled. Seizing the needed funds would be undemocratic and unconstitutional—they must be borrowed. But the government may be borrowing funds that would have been spent by the lender anyway, so that it is just substituting its own spending for that of individuals. To be certain of getting hoarded funds, the government must probably borrow excess bank reserves, at the same time spreading easy-money conditions by monetary action, so that government borrowing would not raise interest rates and discourage private borrowing.

Again, the funds must be so spent as to stimulate private investment most. If all government funds go immediately to businessmen who hoard them as profit instead of using them to replace plant and equipment, government deficit spending is not fulfilling its function at all. These funds must go into the hands of individuals who will respend most of them immediately on current output of American producers who will in turn respend most of the receipts on consumption, capital replacement, or capital expansion. With each respending it is true that a certain portion of the funds will leak into hoards, so that the direct effect of government spending in raising national income will not be continuous. Therefore, it will be successful in raising the level of national income permanently only if it stimulates the American businessman to invest his own or borrowed funds in private enterprise.

An equivalent amount of private spending would probably give the businessman that necessary stimulation, but government deficit spending might cause him to react quite differently. He might feel that, if the government spending is only temporary, the increase in national income will likewise be temporary, while if it becomes permanent, the policy will endanger the whole economic system. Either procedure involves a risk which might impel him not to replace or expand, especially if it is accompanied by a business reform program.

Villard considers these indirect effects of government spending so important as to dwarf the direct effects by comparison, and admits that the program can succeed only if the government creates an atmosphere conducive to favorable, rather than to adverse, indirect effects. If a reform government institutes the deficit spending program, it may find it necessary to sacrifice some reform measures which might hinder the effectiveness of the spending program. But "unless spending takes a form directly competitive with private business, there is no reason why an adverse effect should be of any importance, despite the inevitable tendency of businessmen to blame the government for everything they dislike." (Page 353.)

Even if the deficit spending program meets all the requirements suggested, and revives business activity, the job is not finished. If the borrowing is to be cyclical and temporary rather than secular and permanent, the program must provide for repayment. Taxation as heavy during prosperity as it was light during the depression period must occur, if the government expects to maintain its usual services as well as to pay the debt during the recovery period. But "it is not enough for the government to spend in excess of its receipts during depression and to have receipts in excess of its expenditure during prosperity... If the debt is to be retired, it must be retired out of funds that would otherwise have been saved. . . . Otherwise it is possible that the program will do as much harm during prosperity as it does good during depression." (Page 368.) But such hoarded funds are difficult to spot and to single out for taxation during the recovery period. And even if they are secured, injecting them into circulation to repay the debt might tend to inflate the boom so far and so rapidly that the succeeding slump would be disastrous. This contingency can probably be met best if the central authority utilizes its monetary and banking powers to curtail bank credit whenever it feels the boom is getting out-of-hand.

Critics of the plan as outlined suggest that if the government borrows the funds from hoards during the depression, and re-

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "Deficit Spending and the National Income," by H. H. Villard, Farrar & Rinehart, Inc., New York, N. Y., 1941.

pays the loans by taxing hoards in prosperity, it might advisedly short-cut the process by taxing hoards during the depression. Villard gives two reasons why this is not feasible: (1) There is too much political pressure against increased taxation during depression periods. (2) "Taxation of the savings under discussion . . . requires more time and planning than deficit spending. . . ." (Page 367.)

Not satisfied with the theoretical rectitude of deficit spending, Villard attempts to measure the actual results of the government's test case on deficit spending during the thirties, and concludes that it *may* have been effective in stimulating business activity. Before 1933, funds at least partially borrowed from hoards were spent without much chance of adverse indirect effects because they were conservatively administered by a "business" government; yet they did not prevent large withdrawals of cash from circulation, which caused a drop in private investment and national income. Villard concludes that this deficit spending was not strong enough by itself to stem the tide of recession, though it probably did offset hoarding somewhat. He maintains that a bigger spending program might have succeeded, especially if accompanied by easier money conditions. To justify this stand, he indicates that the all-out deficit-spending program during 1934–1936 apparently bore fruit in private investment which far exceeded government investment in size, more industrial borrowing from banks, and a pronounced rise in national income. There were no other apparent reasons for the recovery.

The 1937 slump he attributes largely to the curtailment of government spending after mid-1936, which sounds reasonable inasmuch as the recession ended soon after deficit spending was resumed in 1938. But he admits that the results in 1937 also indicate that this first case of deficit spending failed in its basic objective, i.e., to stimulate private investment enough so that private investment would push the recovery movement to complete prosperity and full employment by itself.

What is Villard's explanation for this failure? Just this: That the period of the thirties involved more than a periodic depression; it brought to the fore a problem affecting our national income which the government's cyclical deficit spending policy was not tailored to fit. That problem is a continued high level of savings accompanying a secular decline in private investment which can permanently impair the level of national income and employment unless offset by drastic governmental action.

This secular stagnation theory is explained by Prof. Alvin Hansen, "who believes that private investment demand will be inadequate basically because of the slowing down in the rate of population growth. . . It was necessary in the past to save simply in order to maintain the existing standard of living, and this need may have led to a level of saving completely inappropriate to the conditions found with a static or nearly static population. . . The prosperity of the twenties rested heavily upon: (1) The deficiency in residential building that resulted from the postponement of such construction during the war; (2) public construction, 'financed heavily by [state] government deficits;' (3) a large export surplus, made possible by foreign loans; (4) the rapid growth of the automobile industry; and (5) the growth in the importance of consumers' durable goods. . .

"Few would deny that these factors were of great importance in explaining the postwar prosperity. Further, it seems likely that some of them will never again be as relatively important as they were at that time. . . Those inventions likely to be exploited soon appear to involve expansion either at the expense of existing industries or in the production of existing, well-equipped industries. A change of radio broadcasting from amplitude to frequency modulation would probably not strain existing capacity in the radio industry, while television or a cheap airplane would involve expansion at the expense of present motion-picture exhibitors and the automobile industry." (Pages 94, 344.) Though our author seems to disregard the fact that the inroads which the now flourishing industries made on their predecessors should have had similar economic effects, and did not, there may be more than a grain of truth in this "tendency towards secular stagnation."

What is Villard's nostrum for this problem? He suggests two alternatives: (1) Extend deficit spending over the recovery as well as the depression phase of the business cycle, paying off both debt and debt interest, if necessary, by further borrowing. But he fears such a policy of continually expanding the national debt, not because he anticipates default, because he recognizes that an internally held national debt should have no direct effect on the real income of the people, but because an expanding debt would distribute a larger percentage of the national income into the hands of capitalists. This concentration would not only be socially undesirable, but would also restrain the deficit spending program from meeting its desired objectives, since more and more of the funds would leak into private hoards as interest payment instead of into private investment or consumption. More important—the policy would probably have indirect effects on businessmen of the country so adverse as to offset the contribution to investment made by the expenditure directly.

(2) Consequently, Villard recommends that the government levy additional taxation on hoards over the cycle, so that it may buttress private with public investment continuously without inflating the national debt continuously. Let it be remembered that this solution applies only to the secular problem. *Cyclical* declines in investment, Villard reasserts, can be met most expeditiously by borrowing and spending our way to prosperity, at which time we may then repay without restraining the boom by taxing heavily those funds which would not otherwise be used. Over the cycle we *can* have our cake and eat it too.

Engineers in Postwar Planning

(*Continued from page 814*)

largely consist of major public works of the nonrevenue class.

It would seem that more benefit to the public, to labor, and to industry would come about through greater stress on industrial income-earning undertakings. This latter sphere is rightly the concern of management and engineers, and in it The Engineering Society of Detroit should play a major part.

First, it is most desirable that the E.S.D. and its affiliate societies create a committee of the right kind of people to formulate a program for bringing to public notice the need for planning now for postwar employment. Second, the E.S.D. should stimulate the active participation of all concerns employing labor in Detroit, together with the Chamber of Commerce and other civic bodies. Third, the E.S.D. should offer to enlist the services of keymen in Detroit for compilation of a plan of industrial demobilization and work organization to take effect immediately as transition from defense production to peaceful industry becomes necessary. Fourth, the E.S.D. is in a position to, and should volunteer to, coordinate all activities and projects of the constituent bodies of a Detroit planning committee.

Without doubt, financial aid will be forthcoming both from those industries who stand to benefit by this program, from the civic bodies representing the public, and from the trade organizations who stand to lose so much in a failure to formulate a postwar program. There is every assurance that affiliate societies will wholeheartedly back any joint movement proposed.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Unions and Professions

AMERICAN CHEMICAL SOCIETY

ENGINEERS, as well as chemists, will be interested in the statement of the board of directors of the American Chemical Society which follows:

Because of efforts to compel chemists and chemical engineers to join labor organizations in order to obtain or retain employment in certain plants, the board of directors of the American Chemical Society has given consideration to the broad problems of employment in the field of chemistry.

So that the position of the Society may not be misunderstood, the board of directors issues the following statement for the more complete information of our membership:

The Society has taken no stand against "collective bargaining" for professional men when such bargaining is not controlled by nonprofessional groups and where the bargaining unit is composed exclusively of professional men.

The Society condemns no one of its members for joining any noncoercive labor union so long as he does so voluntarily.

The Society, however, is unalterably opposed to the forcible inclusion of professional men in bargaining units dominated and controlled by nonprofessional employees, whether that inclusion be brought about by economic pressure upon an employer, by intimidation of the professional employee, or by operation of either state or federal law.

The Society will bend every effort to maintain for all its members the "right to work" and the "right to employment and promotion" on the basis of worth and merit.

Accordingly the board of directors goes on record as opposed to affiliation of its members with any organization that conditions promotion primarily on the basis of "seniority" or that insists that they join any labor organization where they would be in a minority, with no power to protect themselves while paying "protection" thereto as an essential to the privilege of earning a livelihood and with their wage scales negotiated by those whose selfish interest would require that benefits be sought for the larger number of nonprofessional workers to the detriment of the relatively few professional employees.

Letters from some members, supported by facts and intelligent argument, claiming that conditions during the depression and under the emergency have secured for tradesmen and laborers, under union leadership, advances in income not enjoyed by trained professional men often directly associated with the former have been given consideration.

Already a number of our more progressive employers have made surveys of their personnel and have taken, or propose to take, corrective measures.

In order that some logical conclusion may be reached, it seems wise to consider the distinction between professional and nonprofessional employees engaged in chemical work in order properly to differentiate between professional and nonprofessional workers.

At the present time there are a large number of technicians employed in the field of chemistry.

The term "technician" may be applied to routine workers, trained in the laboratory but with no special education or mental proficiency in chemistry and allied sciences. Normally they will be individuals with secondary-school education only, or perhaps ones who have failed to acquire a baccalaureate degree through lack of funds, insufficient effort or capacity, or attendance at underequipped educational institutions. These are almost always paid wages on the hourly basis and are often included in labor-union agreements. No proper objection can be raised to their inclusion in a bargaining unit composed of employees doing various kinds of skilled, semiskilled, or unskilled work.

The two groups of employees which should not be subjected to forcible inclusion in a heterogeneous bargaining unit are those who have received degrees in chemistry or chemical engineering and are engaged in these fields, either as chemical internes or as professionals.

The term "chemical interne" may be applied to those who are essentially in the final qualifying stage for their lifework in the field of chemistry. They have received their baccalaureate degrees with majors in chemistry or chemical engineering, have proved their proficiency not only in chemistry but also in mathematics, physics, modern languages, et cetera. They are acquiring thereby the necessary training and experience to qualify for full professional status or standing. Those in industrial corporations are engaged in professional work on problems confidential to management, whether their work be control, research, or development.

The term "professional" should be applied only to those who have the baccalaureate degree, or its equivalent by specific accomplishment, and who, having been graduated from institutions approved by the American Chemical Society, have had at least two years of postgraduate training in chemistry or chemical engineering in institutions of like grade or have for an equal period obtained experience in chemical work. For graduates of other educational institutions five years of postgraduate training and/or experience subsequent to the baccalaureate degree should be required. These are the minimum requirements for full professional membership in the American Chemical Society.

The Board of Directors has heretofore hesitated to make any suggestions on the matter of adequate compensation. On the whole our educational institutions and chemical corporations have realized the value of brains and have compensated employees accordingly. The chemical profession as a whole is on a level with any other profession in material return. There are today in our profession, as in many others, individuals whose compensation is high, indeed almost fabulous, and others who are grossly underpaid. There are many who, even in the higher brackets, earn more than their income. There are some, even in the lower brackets, who are not worth their hire, and who should, for their own sakes and for the reputation of the profession, seek other more fitting fields for a livelihood.

NEW ANTIAIRCRAFT-GUN MOUNT

(The first 90-mm antiaircraft-gun mount to be produced by private industry in the United States was turned over to Army officials at the LaPorte, Indiana, plant of the Allis-Chalmers Manufacturing Company on September 17, 1941. It is this mount, with the 3858 separate parts that compose its delicate mechanisms, on which the gun depends for its extreme accuracy and great mobility. The unit can be unlimbered from traveling position and put into effective firing position within six minutes. The gun forces an explosive projectile some 35,000 feet into the air, an altitude higher than most bombers fly.)

In spite of this generalization there has come to the attention of the Board of Directors evidence that there are today many cases where worthy professional men with years of study and training are grossly underpaid and are receiving less compensation than men without any specialized education employed in many of the trades and crafts.

In the opinion of the Board of Directors, the time has arrived when it must publicly suggest to all employers of chemists and chemical engineers that they review with care their employer-employee relations in this line of endeavor. The American Chemical Society stands ready through a carefully chosen Committee on Economic Status to act in an advisory capacity both to employers and to employee groups of its members and, if deemed helpful, to publicize its findings. Enlightened management will, it is believed, welcome consultation with such a committee composed of carefully chosen individuals.

As a beginning, the board of directors suggests that all worthy chemical internes and professionals when engaged in professional work be paid on a salary and not on an hourly basis.

The extent of training, experience, and capacity, as well as individual personality and merit are factors that must be considered when employing one to engage in professional work. Bearing these factors in mind, as well as the objects of this Society, and the requirements for membership therein, the Board ventures to make the following suggestions to employers for their consideration in respect of starting salaries for chemical internes and professionals under present economic conditions when such persons are employed to do professional work:

A minimum starting salary not less than $1500 per annum for any chemical interne; and one of not less than $1800 per annum for any chemical interne of better than average ability or training, including especially those graduated from institutions whose chemical work is of particularly high quality such as those approved by the American Chemical Society; and a minimum starting salary of not less than $2400 per annum for any individual who has attained "professional" grade as hereinbefore described, and, according to the extent of training and capacity, higher starting salary in proportion to training, experience, merit, and individual accomplishment.

The foregoing suggestions are for minimum starting salaries only and are not to be regarded as suggestions for maximum salaries or as recommendations for a wage scale. They are made in respect of only those who are engaged for professional work in the field of chemistry and chemical engineering, as the Society cannot concern itself with problems of employment in other fields.

Inasmuch as technicians normally come under nonprofessional status, the technician grade does not come within the purview of this organization.

The Board of Directors recommends to employer and employee alike personal contact and careful consideration before concluding financial arrangements. Also it respectfully reminds both employers and members of this organization that the Employment Clearing House held at the semiannual meetings of the Society affords special facilities for consultation.

The Committee on Economic Status will give its immediate consideration to the whole question of employment in professional work in the field of chemistry.

Strategic Metals

OFFICE OF PRODUCTION MANAGEMENT

AT THE request of the Office of Production Management, the Advisory Committee on Metals and Minerals of the National Research Council of the National Academy of Sciences has been conducting a survey of strategic metals.

Reports are now available on the present status of various metals together with suggestions for their conservation and substitution. Reports on antimony, tin, chromium, tungsten, and vanadium have been issued, and those on zinc and graphite will be ready shortly.

The following is a section on general considerations taken from the report on vanadium.

GENERAL CONSIDERATIONS IN SUBSTITUTION OF ALLOYING ELEMENTS IN STEEL

Unless thought is taken in selecting a substitute or several substitutes for a scarce metal, the results are likely to be the creation of new bottlenecks. Moreover, the conservation of substitute metals in the form of low-grade domestic ores for a future emergency when technology shall have advanced so that it will be easier to handle them than it is now, so that fewer man-hours per ton will be required, also needs consideration.

The value of alloying elements is somewhat measured by their present cost, which reflects the man-hours required, but not entirely, since some of the cheaper as well as some of the more expensive elements are unique in the properties they confer. Reservation of scarce alloying elements to produce these unique, nonreplaceable effects, and substitution of less scarce ones for production of effects that can be had in other ways, should be the guiding principle.

The roles of vanadium in high-speed steel, of chromium in stainless, of manganese in controlling sulphur so as to make steel rollable, cannot today be played by any other elements. The strengthening effect of these elements can, however, be obtained in a variety of other ways.

Among alternate elements, the one to be chosen under present conditions is the one available in the greatest profusion in domestic ores (with due regard to man-hours required in production of the metal), or if importation must be made, the one that can be imported in the least heavy or bulky form (high-grade ore) over the shortest shipping route.

The primary alloying elements in steel are C, Si, P, Mo and W, Cu, Ni, Cr, Mn, V, Al, Ti, and Zr. Of these, carbon may be used at will, but its employment is limited by the lack of toughness of high-carbon steels.

Silicon is available in utmost profusion as silica. By use of man-hours and electric energy we can have as much ferrosilicon as we will.

Phosphorus is in the same category as silicon, there is plenty of phosphate rock. With man-hours and electric energy provided, there is no limit to the amount of ferrophosphorus. Both silicon and phosphorus are cheap. Phosphorus is, within limits, a very useful strengthening element for low-carbon wrought steels.

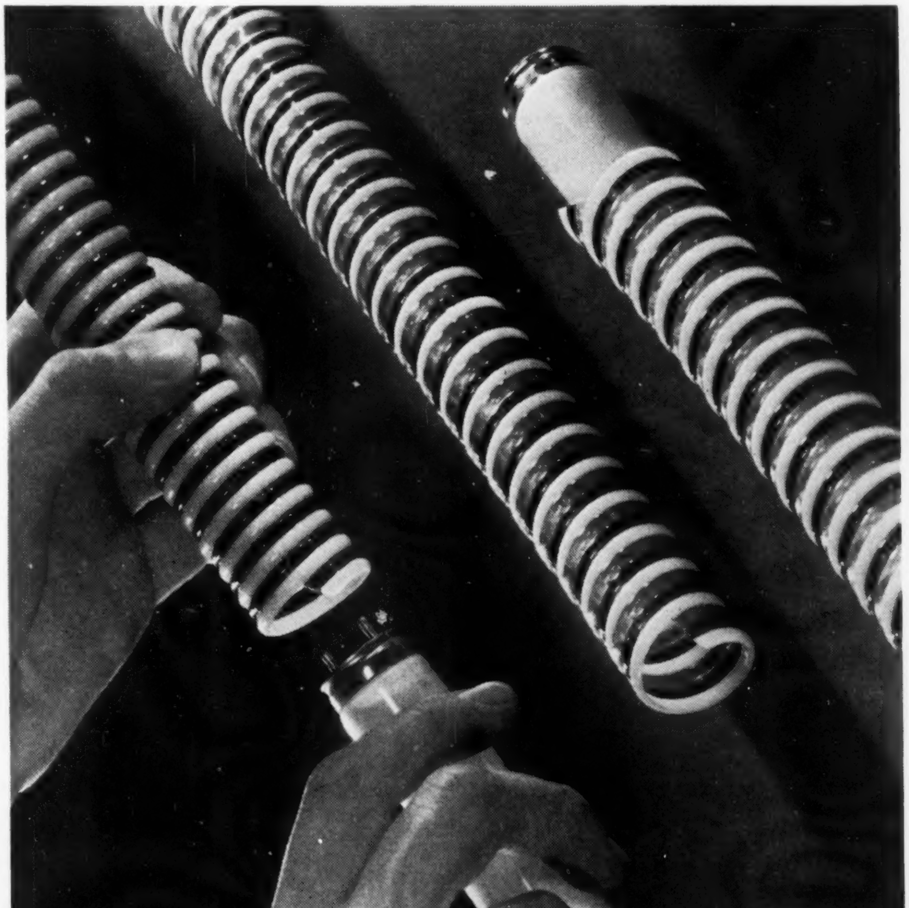
Molybdenum is quite plentiful, coming direct from the ores, and as a by-product from certain copper ores. It is a very potent element, a little does a lot, and in most of its uses in steel it can be employed as the oxide so that no smelting step is necessary. It is relatively expensive, about 85 cents per lb contained Mo. (Tungsten, while important in high-speed tool steel, is very largely replaceable by Mo.)

Copper, tight at the moment because of nonferrous uses, is a useful alloying element in steel, used in limited amounts (lest edge cracking occur on rolling). It is cheap, 12 cents per lb, and at a higher price more could be made available from domestic ores mined with difficulty. If importation is necessary, South America can add to the supply.

Nickel is at present exceptionally tight, so that a metallurgically inordinate avoidance of its use except in actual munitions and first-line-defense parts, is current. Since shipping is from Canada, and the price is 35 cents per lb, a return to a limited use of nickel in other products (especially by intelligent use of nickel-alloy steel scrap) will be logical when it can be permitted. In austenitic stainless steel nickel is scarcely replaceable. Use of half or less of the customary amount of nickel in pearlitic steels along with an equal or somewhat greater amount of copper often produces results like those with all nickel and avoids difficulties that arise with copper alone. Scrap high in copper may lead to edge cracking in rolling. Addition of a suitable amount of nickel or nickel-containing scrap would prevent this and widen the available scrap supply.

Chromium is relatively cheap, but is derived largely from imported ore that comes in over long sea lanes. Domestic low-grade ore supplies are not inexhaustible. The role of chromium in stainless and heat-resisting alloys, and in high-speed tool steel is unique. A fraction of a per cent is useful in many other steels, and in some of them replaceable only with difficulty, but in many others it is easily replaceable. Care needs to be taken to devote Cr only to its essential, nonsubstitutable uses. This has not been done so far.

Manganese is normally one of the cheapest alloying elements and is used in the largest amount. High-grade ores have been imported over long sea lanes. There is a fairly large, though hardly inexhaustible, supply of low-grade domestic ores, but the know-how for reasonably economic utilization of them is still lacking, though it is being sought. On the outcome of such studies rests the degree to which manganese can continue to be utilized in its replaceable applications. Only limited and doubtful application of substitute elements might be made in its main role, that of controlling sulphur and making steel rollable, whereas its strength-giving effects may often be satisfactorily obtained in other ways. At least until the handling of



PLASTICS COLOR FLUORESCENT LIGHTS

(Thin strands of tenite, a shatterproof plastic, wound into tight, spring-like coils and slipped over fluorescent tubes serve a double purpose. Made in various combinations of clear transparent and translucent colors, they add to the decorative value of the fixtures and aid in color correction. They are also used to remove objectional glare and to add warm color to lighting.)

low-grade domestic ores is worked out on a much larger scale, extreme caution is needed in employing manganese where other elements will serve.

Vanadium at $2.75 per lb contained V is a precious jewel among alloying elements. It cannot be substituted for in high-speed steel. In many other uses it can be approximately substituted for, but not in all. About half the supply comes from domestic ore, about half from Peru. Extension of its use in unnecessary fashion either depletes our own reserve or involves shipping. Because, in other than tool steels, the usual addition is only 0.05 to 0.15 per cent V, the cost has not been a sufficient deterrent to its inordinate use in the process of replacement of nickel steels.

Aluminium is used in very small amounts, 0.05–0.10 per cent, as a grain-size-control addition to steel (impure secondary aluminium, or complex ferroaluminiums will serve). In this use it largely replaces vanadium, and as its cost is only 17 cents per lb, it is desirable to make this replacement, since there is a far greater supply of domestic low-grade ores of aluminium suitable for making a type of aluminium that will serve this purpose, than there is of domestic vanadium ore. Provision of the small amount of Al necessary is vital, but requires only man-hours and electric energy. In spite of the shortage of pure aluminium for aircraft use, expansion of production facilities for metallurgical (steelmaking) grade of aluminium or of ferro-aluminium is just as easy as increase in facilities for any other metal, and no foreign ore nor overseas shipment is needed.

Titanium and Zirconium play minor roles much like that of aluminium. Both have been imported. Zirconium would continue to be, so its use will decline until shipping is again available. Domestic titanium-ore deposits are now being developed and with man-hours and electric energy, ferrotitanium can be had. Contained Ti is, however, inherently somewhat more expensive than Al, so where either will serve, Al will be the choice. Titanium has some uses for which Al does not exactly serve.

PRIMARY CHOICES

It is obvious from the foregoing that, under present conditions, the substitute alloying elements that can be used at will without involving shipping or depletion of domestic resources are silicon, phosphorus, aluminium, and titanium. Next in order come molybdenum and copper. Chromium and manganese need more careful selection of applications than the previous six. Nickel, for the present, needs still more careful scrutiny of uses, and vanadium should be the most carefully restricted of all, from the shipping and depletion point of view, also because it takes the most man-hours and electric energy per pound.

Hence silicon-molybdenum or plain molybdenum or plain silicon wrought steels, aluminium treated for grain-size control when that is necessary, low-carbon steels employing phosphorus, with or without Si or Mo, and cast steels using copper and molybdenum or copper and silicon as alloying elements are the ones upon which to focus attention. Restricted use of chromium, manganese, and vanadium to supplement these basic compositions will, of course, be necessary.

Such principles need to be kept in mind in the consideration of any particular alloying element.

Engine Supercharging

JOURNAL OF THE AERONAUTICAL SCIENCES

THE September, 1941, issue of the *Journal of the Aeronautical Sciences*, Aeronautical Review Section, contains a history of the development of superchargers for internal-combustion engines. The World War of 1914–1918 marked the start of serious research on superchargers for airplane engines and from the beginnings in England, France, and Germany, and the experiments of Sanford A. Moss, Fellow A.S.M.E., in this country the developments are traced to the present time. A three-page bibliography is included.

Drawings on Metal

VARIOUS SOURCES

MENTION was made in this department in the August, 1940, issue, page 617, of one method used in the aircraft industry for speeding up the production of templates, jigs, and fixtures by the use of photography. The success of the aircraft industry in the use of processes for transferring, to metal sheets or other material, of drawings, photographs, template outlines, and printed matter has been amply demonstrated.

Undoubtedly these processes will continue to find new applications as their advantages become better known.

The principal processes used are:

1 Photographic printing on sensitized metal sheets:
  - (*a*) Contact printing from regular tracing cloth or paper
  - (*b*) Contact printing from special drawing materials having low coefficient of expansion
  - (*c*) Contact printing from drawings made on metal plate coated with fluorescent material. Exposure made with X-rays through back of fluorescent plate
  - (*d*) Projection printing:
    - (1) Full-scale projection from full-scale drawings
    - (2) Enlargements and reductions

2 Electrolytic printing

The smaller sizes of photosensitized metal are available commercially and these can be stored before use the same as ordinary film. For larger plates the difficulties of packing and shipping make it preferable to install apparatus to do the coating locally. In addition to metals many other materials such as plywood, plastics, and fabrics can be sensitized. With a slow-speed emulsion the sheets can be printed and developed without the use of a darkroom.

To take the place of blueprints in the shop or field, metal prints are more permanent and will withstand rough usage without damage or obliteration of dimensions. Confidential drawings can be printed on heavy metal sheets that cannot be removed from the shop without detection. Photographs of finished parts can be put on the same sheet with the drawing to aid in its interpretation.

Name plates and permanent instruction sheets can be made quickly for attaching to machine tools and machinery.

Many parts such as metal or plastic dials can be made with dial markings reproduced photographically.

For cutting sheets to shape in sizes or quantities that make the use of a die unpracticable, the design can be transferred to each sheet, or, if several sheets can be cut at one time, a photographic sheet can be made for the top of each pile.

In cases where templates, jigs, or fixtures must be laid out with extreme accuracy, it is necessary to take precautions against the expansion and contraction of the drawings.

One company has made available a special drawing material, for this service. It is claimed that, aside from a low coefficient of thermal expansion, this material has no dimensional change, does not become brittle, and does not support combustion. It is translucent, will take pencil or ink on both sides, and can be refinished and used over again. A special sheet is also furnished with a black coating that is used for scribing.

As used in the aircraft and shipbuilding industries for making templates, jigs, and fixtures, the success of this process depends upon the furnishing by the engineering department of complete full-scale drawings giving all lines, contours, bends, rivet holes, bolts, welding, and all instructions for fabrication. After the drawing has been transferred by contact printing to the metal, the production department can immediately start fabrication. This means that all redrafting, layout, and plotting work is eliminated and that all transfers of the drawing are exact duplicates.

Successful results have also been obtained with projection printing of drawings on metal. A large lofting camera is mounted on wheels and used to photograph the finished drawing on the loft floor. The plate is then used in the projection printer to make full-scale prints or enlargements or reductions to any scale desired. It is claimed that a precision of 0.001 in. per foot is obtained with good equipment.

The electrolytic transfer process is a development made in the aircraft industry for copying templates. It is said to be faster and more economical than the photographic methods, but is limited to actual-size reproductions. In this process the drawing is scribed on a sheet of galvanized iron about 0.040 in. thick, which has had the drawing face coated with an insulating paint. The scribed surface is then sprayed with a transfer solution and pressed against the copy plate in a press. Electric current is passed between the plates and in a few seconds the transfer is complete. After washing and drying, the copy plate is given a protective coating and is ready for immediate fabrication.

Any number of copies can be made from the master plate. The size is of course limited by the size of press available. A press 4 ft × 12 ft has been constructed by one company. Sponge-rubber pads are used on the surface of each platen to press the plates together, and flexible metal strips on the rubber surfaces serve to make the electrical contacts. The pressure is obtained by weighting the top platen. It is understood that this process has been made available to defense industries under a licensing agreement.

Acknowledgment is made of the following sources of information for this article:

Journal of the Aeronautical Sciences, Aeronautical Review Section, June, 1941, p. 49; "Giant Camera Speeds Defense," *Popular Photography*, August, 1941; "Metal Film for Motion Pictures," *Metals and Alloys*, December, 1939; "Templates in Five Minutes," *Western Flying*, April, 1941; also Metal Photo-Drafting Company, New York, N. Y.; Republic Engineering Products, Inc., New York, N. Y.; Eastman Kodak Company, Rochester, N. Y.

Post-Defense Income

EDISON ELECTRIC INSTITUTE

ADDRESSING the Edison Electric Institute at Buffalo last June on the partnership between manufacturers and the power industry, David C. Prince, manager, Commercial Engineering Department, General Electric Company, and president A.I.E.E., presented a chart, Fig. 1, showing a division of a gross national output of 110 billion dollars estimated to result from continuing full employment of 57 million persons for 43 hours per week in 1943 and 1946.

If the nation can produce $110 billions worth of products for war, he said, it can do it for peace, but it will have to work almost as many hours to do it. Considering the number of our population who have not yet enough food or proper homes, to say nothing of radios and automobiles, we believe our people will prefer to work for $110 billions than loaf for a lesser income. In the case of peace products the distribution of productive effort will be different from that for war. A reasonable peacetime distribution of such effort has been indicated. Besides being reasonable from a production standpoint, it must be reasonable from a purchasing-power standpoint. There must be people with purchasing power to buy the products. The three categories—subsistence, above subsistence, and consumer durable goods—add up to $77 billions, or $13.5 billions more than the $63.5 billions in these categories in 1940. In 1940, 67 per cent of the national income paid out was in the form of wages, salaries, relief, and social-security payments. Applying this same percentage to the estimated national income paid out for 1946, the total wages, salaries, social security, etc., would add up to $67 billions or $17 billions more than in 1940.

The wage earner's increase in purchasing power is more than enough to buy the added production of consumer goods suggested.

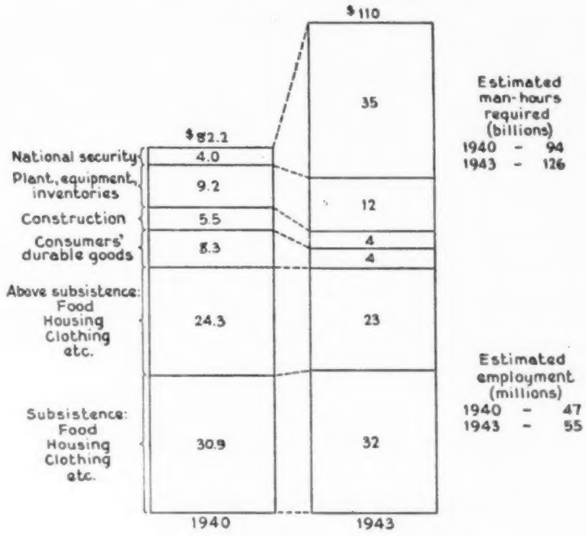


FIG. 1 DIVISION OF GROSS NATIONAL OUTPUT
(Billions of dollars.)

The wage earner can be depended upon to spend his wages; he always has, even before the policy was adopted of caring for the profligate as well as the unfortunate at some minimum level. The detailed make-up of the $77 billions that will be spent by individual consumers is closely predictable. Department of Labor and other statistics show the distribution of expenditures at every income level. As each family income is increased, its expenditure pattern conforms to the group into which it moves. Our store buyers know how to add up the figures to determine how many washers and vacuum cleaners are involved.

The allowance of $10 billions for construction contemplates $6 billions for the erection of 1.5 million homes in 1946. Three hundred and twenty-five thousand are needed for replacements and new families; 500,000, to make up for wartime deficiencies; and 675,000, to replace dwellings unfit for occupancy. This compares to a previous high of 900,000 in 1925. At 1.5 million it would take nearly 25 years to house our whole population. A low rate of construction for many years, during the first World War, the Great Depression, and now this new war, has created a housing demand which cannot be quickly filled. The working classes will either buy or rent these new homes with the purchasing power which they have gained. Statistics show how many will be needed. This building program may require stimulation by large-scale housing corporations similar

to those developed in England after the World War. These will not require government subsidy, because with full employment our people can pay their own way and will prefer to do so.

Based on data for the past years, public construction of superhighways, water supplies, sewerage facilities, public buildings, etc., should require about $4 billion to satisfy our needs.

It is anybody's guess whether $10 billions will meet our defense and foreign-trade needs in 1946, but the amount will be gladly spent annually for years if it insures a world at peace. In a sense the plant and equipment item represents the capital investment required to make the economy operate and expand. From it the wear and tear must be made good. But much of the deterioration will be in obsolete armament plants, while the new investment will be by the provident in converting a wartime to a peacetime production. That expenditure is in our hands.

Our partnership of power and manufacture will not have to create the 1946 economy out of whole cloth, but by planning the expenditure of the $13 billions for plant equipment and inventories, which represent growth, we will be able to regulate the system so that it runs steadily. Classical economists supposed that such things were taken care of by the laws of supply and demand. We know to our sorrow that either by nature or due to human interference our machine age is unstable and does not regulate itself. The problem is to decide, as between government and business, who will do the regulating.

Let us make a plan showing how we think the transition from a wartime to a peacetime economy should be made. The plan should contemplate progressively higher standards of living brought about by greater power consumption. If it is a good plan, we should be able to sell it, but we will have to start soon if we expect to have our plan ready in time.

Cargo Carrier, "Sea Otter II"

MARINE ENGINEERING AND SHIPPING REVIEW

THE October, 1941, issue of *Marine Engineering and Shipping Review* contains a description of a novel type of cargo vessel, designed for low-cost quantity production, and sponsored by the Navy Department as at least a partial answer to the submarine threat on the North Atlantic.

The first full-size vessel of the new type, built for experimental purposes at the Levingston Shipbuilding Company, Port Orange, Tex., is known as the *Sea Otter II*. Since the results of the trials will not be known for some time, the Navy Department has curtailed all but a brief announcement of the details of the vessel which was given out on September 18. Certain other information has become available concerning the early history of the project, so that the essential facts regarding this revolutionary vessel may now be stated.

The basic design, from which departures in size and power are proposed for various types of service, has the following general characteristics:

Length over-all, ft and in	257, 6
Length between perpendiculars, ft	250
Breadth, molded, ft	40
Depth, molded, ft	21
Load draft (exclusive of propellers), ft	11
Load displacement, tons	2250
Dead-weight capacity, tons	1622
Brake horsepower	1760
Speed, knots	12

The vessel is of all-welded construction, employing rectangular plates which require almost no bending or rolling, except at the bilges. The flat keel is constructed of $^1/_2$-in. plates, and $^3/_8$-in. steel forms the rest of the hull. There are two longitudinal bulkheads and eight transverse watertight bulkheads.

Since the vessel in loaded condition is low in the water and will be awash most of the time at sea, a sponson has been erected at the bow which provides extra buoyancy and better seaworthy qualities.

A single deck house, located aft of amidships, comprises the wheel house, gun platform, signal station, and living accommodations for 15 persons. One lifeboat is carried. The crew consists of a captain, three quartermasters, two engineers, one radio man, and one cook, making a total, normally carried, of eight men. The engine room is also located aft of amidships.

That the entire structure represents almost the irreducible minimum of labor and materials required in the construction of a seagoing cargo vessel is evidenced by the fact that the first ship was built in two months' time.

The *Sea Otter II* has a hold capacity of 122,800 cu ft bale measure. The long-range fuel capacity is 182 tons, which at 11 knots will give a cruising radius of 9050 nautical miles, and at 12 knots, 7419 nautical miles. Normally the vessel will carry 95 tons of fuel, providing a cruising radius of 3700 nautical miles at 12 knots. Other tank capacities are: fresh water, 5040 gal; fuel oil for oil-burning heater, 390 gal; lubricating oil, 890 gal.

Probably the greatest innovation of all of this strange vessel is the propulsion system, which consists of sixteen 110-hp six-cylinder Chrysler gasoline engines of the type ordinarily used in one of the popular automobiles of the day. The total brake horsepower developed is 1760.

Four batteries of four engines each are arranged to drive four propellers through vertical shafts extending through the bottom of the hull. The four propellers are located transversely across the flat bottom of the vessel in much the same manner as outboard motors, except for the fact that they are suspended just aft of amidships and not at the stern.

Four engines hydraulically coupled to a ring gear are arranged radially around each shaft opening, thus providing about 400 hp to drive each propeller. The two-bladed propellers have a diameter of 70 in. and a pitch of 84 in. The propellers and power-transmission units can be lifted up for repairs while under way, or to reduce draft when necessary to give a maximum of only 11 ft.

Current for lighting, degaussing, and auxiliary use is furnished by a 110-v generator driven by a gasoline engine.

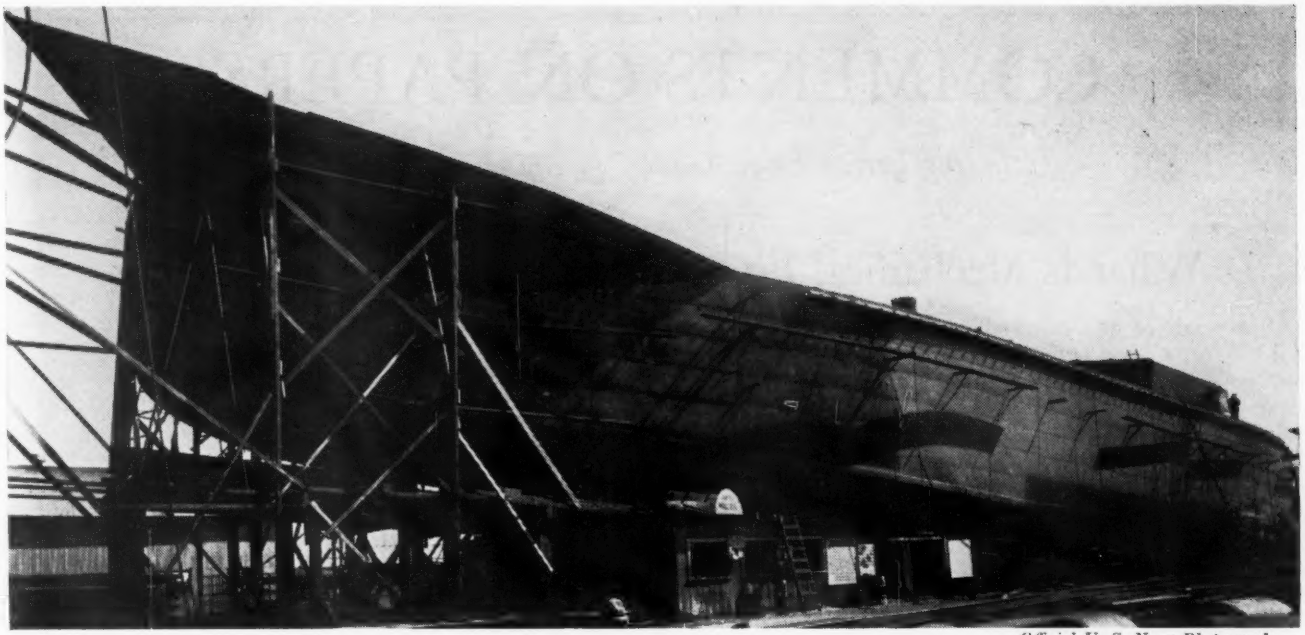
One complete power-transmission unit is carried as a spare. There are in addition two spare propellers and four spare engines.

The vessel has a turning circle of 1000 ft with 32-deg rudder.

DEVELOPMENT OF THE SEA OTTER TYPE

The history of the development of this design is also extremely interesting. Over the luncheon table, one day last February, Commander Hamilton V. Bryan, U.S.N. (retired), and Warren Noble, an automotive engineer, conceived in broad outline a type of ship, propelled by automobile engines, which they thought could meet the challenge of the submarine. Difficulties were experienced in reducing the ideas to practical form, and it was decided to enlist the aid of W. Starling Burgess, vice-president of Weaver Associates, Inc., Washington, D. C. This firm developed preliminary designs, which were tested exhaustively in the Model Towing Tank, at Stevens Institute of Technology, Hoboken, N. J., under the direction of Prof. K. S. M. Davidson.

From this beginning the designs were perfected by Weaver Associates, to the point where it was decided that self-propelled



Official U. S. Navy Photograph

FIG. 2 "SEA OTTER II"

tests could best be conducted on an 80-ft model. Financial support for the project was advanced by R. L. Redmund, former counsel of the New York Stock Exchange, and the experimental model was built at Jakobson Shipyard, Inc., Oyster Bay, Long Island, N. Y. This model incorporating one complete Chrysler propulsion unit was successfully tested on Long Island Sound, after which indicated changes were incorporated in the design for the full-sized ship. At this point support of the Navy Department was forthcoming and an order was placed with the Levingston Shipbuilding Company, Port Orange, Tex., for one vessel. Eads Johnson, naval architect, New York, N. Y., was retained to supervise the construction and to develop basic production methods for building these vessels in great numbers.

Exhaustive trials have been conducted on the *Sea Otter II*, results of which have not as yet been divulged by the Navy Department. That they were completely successful is evidenced by the fact that the Navy Department has announced the formation of a corporation to build this type vessel exclusively. This corporation will be headed by Edward B. Germain, president of the Dunlop Tire & Rubber Corporation, as president and general manager. The board of directors will consist of Secretary of the Navy Knox, Rear Admiral Land, chairman of the Maritime Commission, J. W. Powell, special assistant to Secretary Knox, and a member to be nominated by the Reconstruction Finance Corporation, which will own all the stock in the new enterprise.

A number of patents have been granted to various individuals connected with this development, and these have been pooled as part of the assets of the corporation.

The *Sea Otter II* was built at a cost of about $250,000. Produced in quantity it is estimated that vessels of the same size will not cost more than $100,000 each. Originally it was intended that *Sea Otters* would be dismantled after carrying a full cargo to England, where the engines were to be used in trucks, and the hull steel and structural shapes by British steel mills. The present scheme contemplates a number being used as coastal vessels, trawlers, and the like, and the likelihood is that many will be continued in Atlantic service for the duration of the emergency since, with shallow draft and with low freeboard, they will offer small targets for air or for submarine attack.

Because of the speed of construction and the availability of propulsion machinery, the Maritime Commission contemplates the construction of a number of vessels of this type as emergency tankers, to help relieve the oil shortage in the East.

Working of Magnesium

JOURNAL OF THE INSTITUTE OF METALS

THE attention of those interested in the working of magnesium is called to three papers appearing in vol. 67, 1941, of the *Journal of The Institute of Metals*.

Paper 899, "The Rolling of a Magnesium Alloy," by W. R. D. Jones and L. Powell, is a report of an investigation made to study the effect of cold work and subsequent annealing on alloy Elektron AM503. The work consisted of the production of 10-gage sheets which were then rolled with varying degrees of deformation to 16 gage. The sheets were subsequently annealed at different temperatures and tested. A comparison was made between the properties of sheets rolled from cast slabs with those rolled from extruded slabs of the same composition. The general conclusion was reached that cold-rolling up to 50 per cent extension was not harmful and that annealing at 300 C, although not really necessary, caused slight improvement. Cold-rolling produced marked directional properties which were not eradicated by annealing even at temperatures up to 500 C.

Paper 900, "X-Ray Examination of the Crystal Structures of Rolled Magnesium and a Magnesium Alloy," by D. E. Thomas, is a report on studies of the magnesium and Elektron sheets described in the previous paper.

In paper 901 "The Effect of Antimony on Magnesium," by W. R. D. Jones and L. Powell, it is shown that antimony does not cause any improvement of the mechanical properties or corrosion-resisting properties of magnesium. The solid solubility of antimony in magnesium is very small and the alloys are not capable of age-hardening.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

What Is Mechanical Engineering?

As a result of the editorial entitled "What's Your Definition?" in the June issue of MECHANICAL ENGINEERING a variety of answers have been received by the committee of The American Society of Mechanical Engineers which was asked by the Council to study the definition of mechanical engineering and report to it.

Many definitions of engineering have appeared from time to time of which three are interesting historically.

To Tredgold, 1788–1829, an early English highway engineer, the following is attributed: "Civil Engineering is the art of directing great sources of power in nature for the use and convenience of man."

Thus the social benefits of engineering were recognized and incorporated in the first definition written over a century ago in the charter of the Institution of Civil Engineers.

The economic aspect of engineering was incorporated in the numerous variations of the following: "An engineer is one who can do with one dollar what others can do with two dollars." Who was the first perpetrator of that definition? Arthur M. Wellington, in the introduction to his book "The Economic Theory of Railway Location" says, "It would be well if engineering were less generally defined as the art of constructing. In a certain important sense it is rather the art of not constructing, or, to define it rudely but not inaptly, it is the art of doing well with one dollar what any bungler can do with two after a fashion."

Another statement was that contained in the presidential address of Henry G. Stott before the A.I.E.E. in 1908. It was on the wall of the Engineering Societies Library for many years and read as follows: "Engineering, the art of organizing and directing men and controlling forces and materials of nature, for the benefit of the human race."

MECHANICAL ENGINEERING

There were no definitions of mechanical engineering available when the committee was asked to consider the subject.

A definition was circulated and was included in the editorial mentioned. A number of others have been received of which the following are typical:

"Mechanical Engineering is the science of conceiving, maintaining, and marketing the mechanical machines needed by the contemporary civilization."

Another very cogent statement was: "Mechanical Engineering comprises the art and science of generation, transmission and utilization of mechanical power and includes the development, design, production, application, and operation of all mechanical devices required therefor."

The author objected to including "management" and other words incorporated in the June editorial on the ground that "management and organization are a part of production; 'research' is a part of development; 'marketing' is a phase of application, 'maintenance' is a part of operation." Is there an argument here?

Another definition submitted was: "Mechanical Engineering comprises the science and technology of power generation, of the mechanical transmission of power, and of the production of machine tools and their products. In addition to the research, design, development, and investigation required in creating these services and products, mechanical engineering includes the organization of men, money, and materials and their coordination for effective and economic production."

There were two of very different types. One said: "Mechanical Engineering is one field of human activity which improves the intelligence of its adherents. Perhaps for that reason, it is here where people are rather honest with themselves and with their fellow men. As Archimedes looked for a fulcrum to move the earth, the engineer, through better social contacts, should look for, and find, points of support to control the uses of his work."

A message from Australia contained an original and fundamental idea:

"A Mechanical Engineer is one who substitutes for the primary working capacity of the human being, various mechanical devices, operating in accordance with established Natural Principles, to perform the required work; in greater quantity, in shorter time, and with greater accuracy, with the smallest possible expenditure of human energy."

The committee has revised the definition printed in the June issue as a result of suggestions received and submits the following:

> Mechanical Engineering is the art and science of generating, transmitting, and utilizing mechanical power; of the production of tools, machinery, and their products; including research, development, design, application, and the coordination of materials, personnel, and management.

The mechanical engineer is one who practices the art and science of power generation, the transmission of power, and transportation by mechanical devices; of the production of machinery, tools, and their utilization; and including research, design, development, application, and the management functions of organization, operation, maintenance, and marketing.

Metal-Arc Welding

To the Editor:

In your issue of August, 1941, on pages 585 to 590 inclusive, there is an article by T. N. Armstrong, Development and Research Division, International Nickel Company, New York, N. Y., on "Some Metallurgical Aspects of Metal-Arc Welding of Carbon and Alloy Steels."

This article is both interesting and instructive and whatever criticism I have is very much tempered by the fact that the information given therein is valuable.

The fight I have with this article is that it states principles which do not exist. It is so easy on a matter of that kind to establish a law from inadequate data. This article discusses in some detail the relation between the hardness of the parent metal which has been welded and its safety.

As an illustration I quote the following statement on page 587:

No arbitrary limit of hardness for safe welding can be set, since higher hardness may be tolerated in some applications more than in others. Usually, maximum Brinell hardness between 250 and 300 is considered the safe limit.

Another statement that requires attention is the following on page 590:

This indicates that under certain conditions the weld hardness may equal the maximum hardness obtainable in any steel, and from the broadest point of view it is apparent that steels with very low carbon permit greatest freedom in welding.

I do not wish to argue the case further than to cite the following facts:

(1) There are millions of cases every year of tool bits with Brinell hardnesses well over 600 which are welded as a matter of routine without preheating, stress relieving, or annealing.

(2) There are millions of cases every year where the farmer welds onto his plow new points and replaces worn surfaces. This steel after welding has a Brinell well over 500.

(3) There are millions of cases where rail ends are welded where the finished welded zone has a hardness well over 400 Brinell.

(4) There are millions of cases of welding cast iron and malleable successfully with hardness of parent metal above 500 Brinell.

Since all of these are routine applications and unquestionably successful, which have been made in millions of cases over long periods of time, it is obvious that the statement made by Mr. Armstrong needs some qualification.

In the case of the second statement quoted that low carbon permits greatest freedom in welding, I would make the observation that low-carbon steel is not the best steel to weld with any of the present commercial processes. In fact, it may be difficult to weld. Under many conditions unless precaution is taken it is possible to get a considerable amount of porosity in dead soft steel. If one welds Armco ingot iron considerable difficulty will be experienced because of porosity unless precautions against it are taken. If one is to weld above 0.08 carbon this difficulty for all practical purposes disappears.

J. F. LINCOLN.[1]

AUTHOR'S CLOSURE

It is very gratifying that Mr. Lincoln found the article interesting. He differs, however, with some of the statements, particularly the portion that states that from the broadest point of view the low-carbon steels permit greatest freedom in welding. The author based his conclusion on freedom from cracking rather than upon porosity in the weld, as the latter defect is no doubt due to method of deoxidation during the steelmaking process rather than to the amount of carbon present. The conclusion was not based merely upon the author's opinion but upon voluminous data in the technical literature, which can be found in the reviews prepared under the direction of the Engineering Foundation by Spraragen and Claussen. Further evidence may be found in the "Welding Handbook."

Mr. Lincoln cites specific cases in which cast iron, malleable iron, and steels that harden to 400–600 Brinell are welded successfully by the metal-arc process without preheating, annealing, or stress relieving. As Mr. Lincoln certainly does not mean to infer that these materials may be welded with the same degree of freedom from cracking as low-carbon steels it is somewhat puzzling why these examples are cited. That these high-carbon materials may be successfully welded is readily admitted, but that they are as free from cracking on welding as low-carbon steels is contrary not only to metallurgical principles but to experience within the industry. If such were not the case there would be no need for specifications covering steels of welding grade.

T. N. ARMSTRONG.[2]

[1] President, The Lincoln Electric Company, Cleveland, Ohio. Mem. A.S.M.E.

[2] Development & Research Division, The International Nickel Company, Inc., New York, N. Y.

Marketing and Management[3]

COMMENT BY JOHN R. BANGS, JR.[4]

In 1939, the importance of industrial marketing in the field of mechanical engineering was stressed by the presentation of three papers.[5] In commenting[6] upon the subject, R. T. Kent stated:

"These papers represent the initiation of a movement in the Society's affairs, which if carried to a positive conclusion, may be almost as epochal as Taylor's paper[7] on cutting metals. By the publication of that paper, the Society revolutionized machine-shop practice throughout the world. The principles laid down by Taylor in the paper just cited and in his classic work[8] on shop management, presented before the Society a few years earlier, were at the time held to apply to production only. In the years that have passed, we have learned that Taylor's fundamental principles apply to every phase of industrial and business endeavor. They apply equally well to the problems of marketing as they do to the problems of the machine shop. It is a healthy sign that the A.S.M.E. has at last recognized the fact that it has a mission to fulfill in promulgating these principles in a field which is just as vital to industry as is the production field. If there are no markets there will be no production. It goes without saying, therefore, that anything which can be done to improve marketing methods has a direct effect on all other activities of a business enterprise."

Some engineers may say we are faced today with the problems of national defense and they are production problems. We certainly do not have to worry about markets today. Let us look at the shop where most of our problems lie. The writer would point out that such a view is extremely shortsighted. It is true that many firms have more orders than they can possibly handle today. But what about the inevitable decline? Will manufacturers be able to convert an impending crash into a gradual decline? Will they be prepared for the important period of transition?

Wise manufacturers are looking ahead. The $15,000,000,000 to be spent annually on defense may entirely change market conditions. New manufacturing methods and new products are now in the making. New faces are coming into the sales and production picture. Old customers are setting up new requirements. Potentially, new customers are setting up unheard of requirements.

Competition in the future will not be

[3] "Market Analysis From Management Standpoint," by R. T. Kent, MECHANICAL ENGINEERING, November, 1940, pp. 791–792, 799.

[4] Professor of Administrative Engineering, Cornell University, Ithaca, N. Y. Mem. A.S.M.E.

[5] "Industrial Marketing," comprising abstracts of paper, "The Marketing Movement in Mechanical Engineering," by J. R. Bangs, Jr.; "Gearing Engineering to Sales," by F. B. Heitkamp; "Market Research in Introducing New Industrial Products," by R. L. Gibson, MECHANICAL ENGINEERING, March, 1940, pp. 215–218.

[6] Comment on ref. (3) by R. T. Kent, MECHANICAL ENGINEERING, August, 1940, pp. 621–622.

[7] "On the Art of Cutting Metals," by F. W. Taylor, The American Society of Mechanical Engineers, New York, N. Y., 1907.

[8] "Shop Management," by F. W. Taylor, Trans. A.S.M.E., vol. 24, 1903, pp. 1337–1456; also McGraw-Hill Book Company, Inc., New York, N. Y., 1911.

limited to present competitors, but new ones will continue to spring up. In spite of tempting defense orders, domestic markets must not be neglected. Rather they must be maintained on the soundest possible basis. Truly, intelligent market study is the order of the day. Only by its use can adjustment and financial loss be held to a minimum during the period of transition which will inevitably follow the tapering off of defense spending.

Comment by Tell Berna[9]

The author puts his finger on the key to successful sales management when he mentions "continuing market analysis."

If a firm finds itself in a poor competitive position, a market analyst can be of great service in giving an impartial report of the factors which have created this situation. He can go further and render an even more important service by setting up for that company a means of continuing market analysis so that the sales manager knows at all times the trend of the market, the relative competitive position of his company, and the factors which enter into the increased or decreased sale of his product.

The writer visualizes a sales organization as a channel for information, but it should be a two-way channel. It is not only intended to bring to the customer information regarding the product of the manufacturer but also to bring to the manufacturer information as to the reactions of the customer. We are all too likely to place the emphasis on the first function, while neglecting the second.

Our opinions are naturally colored by our own experience, so that the writer speaks largely from the point of view of a machine-tool salesman. In our industry we have a relatively limited field, and most of us can know our customers quite well. There is no reason why we should not at all times know the trend in the market and should not have somewhere in the plant new features that our customers or our own engineers and salesmen have suggested and which are on test so as to check their value before incorporating them in a new design. In the machine-tool industry, the process of redesigning is a continuing one which is retarded during periods of intense business activity such as the present and which is accelerated when business falls off and management and the engineering staff have correspondingly more time to devote to the development of even better machine tools. If the machine tool is to embody the points which are demanded by the user, then there must be some way in which the demands of the user can be brought to management to be studied, analyzed, and tested. An alert sales force can perform this function and keep management fully advised.

The accounting department of the manufacturer can be of great service in keeping the sales manager constantly advised, not by the preparation of voluminous reports that are as expensive as they are useless, but by giving him a brief running account of what his sales are doing. To supplement this, the sales manager should know the total volume of sales in his field. He should secure an estimate at least, if accurate figures are not available, of the total sales which are being made so that he may constantly be advised of the percentage of the total sales that his company is securing. This is, in the last resolution, the best measure of his effectiveness as a sales manager.

Difficult as it is, an effort should be made to find out on every lost order why that order was lost. This does not refer to the excuses or reasons offered by the customer but the real reason which prompted that customer to make his decision. Unless the salesman is willing to analyze this frankly and report it with equal frankness to his department head and unless the sales manager is prepared to insist on a cold-blooded analysis of the outcome of each transaction, a great deal of valuable information will be lost to the company, and it may follow some outmoded policy blindly until disaster overtakes it, as the author has stated.

In other words, we face our sales problem with the assumption that we have much to learn, that the situation is constantly changing, that no design is permanent, and that the question is what changes are to be made and when they can best be made to advantage in order to meet the changing demands of the market. The opinion of no one customer can be taken without careful analysis and check, but the aggregate opinion of many customers, acquired over the handling of many transactions, should keep a company constantly advised of conditions in the field.

Distant pastures are said to be always the greenest, and it is a temptation to diversify the output of a company by developing a new product, often unrelated to the older ones. The manufacturer's own sales department may not know enough about the new field to appraise its sales possibilities or to give an impartial opinion on the value of the product as a source of future profits. It is in this field that a thorough and an impartial survey by a competent market analyst is clearly indicated and can be of the greatest value.

[9] General Manager, National Machine Tool Builders' Association, Cleveland, Ohio. Mem. A.S.M.E.

Comment by R. H. DeMott[10]

In considering the subject of "market analysis," it appears to the writer that this combination of words is somewhat misleading because of the broad interpretation which is placed upon it by many industrialists. For some years we have preferred the term "industrial development," which we regard as actually broader in scope, consisting of three fundamental factors (*a*) market analysis; (*b*) market research; and (*c*) market development. These factors may be better understood by considering the following brief definitions:

A "market" is a place where merchandise may be exposed or offered for sale. "Analysis" is the resolution of a component into its elements. We, therefore, conclude that "market analysis" is the breakdown, classification, and tabulation of the industry into which our product might be sold.

Let us take the second factor, "research," meaning a systematic study of certain observable data by the experimental method.

We then conclude that "market research" means the placing of our product on test in the industry into which it eventually might be sold; or by some experimental sales program we could feel out the market, thereby determining the details of a broader sales program.

Then the third factor, "development," is a word we like to define as bringing to light and to completion by degrees.

"Market development" would, therefore, be defined by us as the gradual bringing to light of sales possibilities in a particular industry and the consummation of sales in that industry by degrees.

As our market consists of every industry in which wheels turn, we have learned that market analysis, market research, and market development are all important factors in our sales and manufacturing program. Experience has taught us that there is no definite order in which these factors occur. In some cases market development may be the first step and market analysis the last. In other cases market research may be the first and market development last.

We have encountered cases where the data collected about a certain part of an industry through the market-analysis factor would indicate sales possibilities of many thousands of one particular unit per year. No sales, however, of this unit could be consummated. Then, by carrying our activities along the lines of market research and development, we found that certain changes in the type and size of the unit would open up sales oppor-

[10] SKF Industries, Philadelphia, Pa.

tunities of interesting proportions in another part of the industry.

We have experienced cases in industries only partially developed, where it appeared that the actual sales possibilities were quite limited, but activities along the lines of market research and development opened up sales opportunities far beyond our expectations.

In industries where market analysis, research, and development or, in our term "industrial development" appears to be desirable, we proceed briefly as follows:

1 Make a systematic field study of machines in that industry to determine the operating characteristics and the probable advantages through the application of our product.

2 Keep a running record of application recommendations by size, type, and operating conditions.

3 Keep a running record of actual applications by size, type, and operating conditions.

4 Keep a record of successful performance and proved advantages, as stated by customers.

5 Keep a record of failures and every possible bit of information as to the reasons for such failure.

Failure is probably one of the most important elements toward future success if investigated promptly and thoroughly, for through these investigations one finds the need for improved quality, type, service, etc.

Twenty years ago we catalogued 500 sizes and types of bearings, and at that time manufactured practically no bearings of special characteristics. Today we catalogue approximately 1000 types and sizes but actually manufacture 8000 or more; this due to the many special bearings and bearings of special characteristics needed to meet industrial requirements. This is cited as a good illustration of the specific influence of industrial development upon a particular product.

COMMENT BY MORRIS L. COOKE[11]

The first eight words of this paper, "The object of management is to earn profits," constitute such an inadequate and misleading description of the purposes of management as to demand an emphatic challenge especially in times like these. Under our economy, especially in normal times, and in the long run, profits are certainly an essential objective of industrial and commercial enterprise if, for no other reason, than because, in the absence of profits, failure is bound to ensue with all at interest suffering thereby. But surely no friend of our system of private enterprise would want to see management disassociated from its great social objectives such as providing increasing real wages and a higher standard of living for the workers.

As this nation prepares to unsheath its military sword and its industrial might, it would be most unfortunate to have profits unduly emphasized in the wide range of management's vital objectives. There are times when present forfeiture of profits is the only assurance of future profits. It should be recalled that at this moment in Great Britain profits are all but forgotten. Managers in the United States will do well if, in the approaching crisis, profits can be held to their legitimate place in the complete picture.

[11] The Advisory Commission to the Council of National Defense, Washington, D. C. Fellow A.S.M.E.

AUTHOR'S CLOSURE

The author is in substantial agreement with Messrs. Berna and DeMott. He would especially emphasize the ideas expressed by Mr. Berna that the sales organization should be a two-way channel of information for management. No part of an organization is in closer contact with the users of a company's product, and no one is in better position to note trends of sales and trends in design than the salesmen and sales engineers. The ability of a company to maintain its position in its field will, in the last analysis, depend upon the information which these men bring to the management. This statement also applies to Mr. Berna's remarks on the subject of "lost orders," with which the author wholly concurs.

Whether the term "market analysis" or "market development," as suggested by Mr. DeMott, is the correct one to use is a matter of preference, or more properly, of definition. So long as each party to a discussion understands what the other means, the precise term used is immaterial. However, the statement may be made here that there is nothing in industry which causes so much confusion and loss as the use of the same term to define different things, that is, it is highly important that all parties to a discussion speak the same language.

The procedure for industrial development as outlined by Mr. DeMott is logical, and can well be used as a guide in formulating a program. Naturally, every program must be adapted to suit the conditions of the particular case under discussion.

The first eight words of this paper: "The object of management is to earn profits," which Mr. Cooke regards as inadequate and misleading, are, nevertheless, a principal object which must be kept in mind at all times if there are to be industries to manage.

The author is in agreement with Mr. Cooke's second sentence in which he states that in the long run profits are an essential objective. Even in the present emergency, profits are necessary if manufacturers are to contribute to the present and promised future tax burdens that our defense program will require.

There is but one alternative to profits if our defense is to be built up, that is, government operation of industry.

The author will take second place to none in his belief that labor is entitled to a just and even a generous share of the earnings of industry. It is entitled to better than decent working conditions, to reasonable hours, and to intelligent leadership. He has demonstrated this belief by putting its principles into practice in over 30 years' work as an industrial executive. He has also demonstrated that none of the benefits to labor, as cited, can accrue without profits.

In this connection, it may be proper to state that, in general, the attitude of industry engaged in national defense has been that profits are secondary to the defense program. The author's work in the last eight months has brought him into intimate contact with literally hundreds of manufacturers of defense matériel. While insisting that there must be some profit on the work done, all are willing to earn far less than their normal profit, and in many cases they are satisfied to break even. Can Mr. Cooke say the same for labor?

R. T. KENT.[12]

[12] Advisory Engineer, Ordnance Department, U. S. Army, Washington, D. C. Mem. A.S.M.E.

Developments in Continuous Annealing of Steel Strip

COMMENT BY J. B. AUSTIN[13]

Mr. Keller's account[14] of recent developments in the continuous annealing of steel strip and his description of a large-scale process for "Blitz-annealing" contains a number of interesting and provocative points which should, and I hope soon will be, carefully considered and discussed in detail by steel producers.

[13] Research Laboratory, United States Steel Corporation, Kearny, N. J.

[14] "Developments in Continuous Annealing of Steel Strip," by J. D. Keller, MECHANICAL ENGINEERING, July, 1941, pp. 507–513.

My discussion must, however, of necessity be confined to comment on a few matters of special significance, chiefly to the fact that the introduction of such a process as continuous annealing not only alters the annealing operation itself but may also have a significant effect upon subsequent operations, and requires in effect, an alteration of our viewpoint and some of our metallurgical prejudices.

There is no question, I believe, as to the essential desirability of a continuous series of operations of this sort. Continuous processes have long been regarded as good engineering practice and to an impartial observer the present case would seem to be a particularly favorable one for a continuous process, since it is hard to believe in the essential logic of trying to push heat into a large mass of metal in which heat transfer at best is slow, because of the large number of thermal resistances provided by the spaces between sheets or between turns of the coil. Since the time required to reach temperature equilibrium at the center of a pile of sheets or of a coil is proportional to the square of the thickness of the metal the time required for annealing decreases rapidly as the thickness of metal decreases; and it would seem to be worth while to cut down this thickness as much as is feasible. Carried to its limit this leads to a continuous process.

One may well ask then—why has not more been done along this line? Part of the answer is, I believe, found in the fact that a considerable metallurgical art has been built up on the basis of using the particular kind of strip or sheet produced by present box-annealing operations. Any change in the process almost inevitably results in a change in the annealed product and this in turn necessitates a change in the handling of this product, which consumers are naturally reluctant to face. It is amply evident from what Mr. Keller has said that the product obtained by the process he describes differs significantly from the product obtained by box-annealing. Indeed, I think it is quite unreasonable to expect that a material heated rapidly to 1300 F, held at this temperature but momentarily, and then rapidly cooled should have the same properties as a material which has been heated slowly to 1300 F, soaked at this temperature for an hour or more, and then cooled over a period of many hours. For example, both grain size and hardness will differ—and the processes in which the strip is used must be readjusted to the new conditions. This is not to say that such adjustment cannot be made or that it might not result in a better product in the end, but it must be recognized that some adjustment must inevitably result from a change from batch annealing to a continuous process and that such adjustment will require time, patience, and careful development.

Mr. Keller's list of advantages resulting from the use of continuous annealing for strip suggests several questions which I should like to raise at this point. Chief among these are his claims to more accurate control of temper, the elimination of electrolytic cleaning, and the effects of a fairly long time delay. I assume from the stated limitations of 0.025 in. in thickness and 38 in. in width that the furnace described is intended primarily for strip to be used for tin plate. Such material is sold on the basis of its temper and temper must be controlled within fairly close limits. The exact means by which this temper is regulated in Mr. Keller's process are not, I must confess, clear to me and I cannot help but feel that much remains to be done before this feature of the process can be brought under satisfactory control. I also wonder whether this continuous annealing which appears to produce a minimum hardness of around 48 Rockwell C would be capable as it stands of producing the softest tempers.

To return for a moment to the rate of cooling in Mr. Keller's process, as I understand it, cooling is effected by passage through six vertical cooling chutes, a total of about 180 ft of travel, in which the temperature is reduced from say 1300 to 200 F. At a rate of travel of 200 fpm, this corresponds to a cooling rate of something like 1200 deg per minute, which approaches quenching. It seems to me there is little wonder that the annealed strip has a hardness of 48 Rockwell C. I am also a little skeptical about the effects of quench-aging, which Mr. Keller has not mentioned. There is, it seems to me, some danger of a drastic increase in hardness on standing at room temperature.

Mr. Keller's process is also predicated on the fact that complete annealing can be accomplished in a relatively few seconds, a matter on which there is room for considerable doubt. Certainly, if annealing can be satisfactorily carried out in such a short time, our present box annealing is shockingly wasteful. Perhaps it is, and if so, it is high time that the whole box-annealing process were carefully examined. If proposals for a continuous annealing process do nothing more than act as an irritant in tightening up our present practice, they are well worth while; and I hasten to add that I am certain that these proposals will do much more than this.

Mr. Keller has given special attention to gas firing in this operation. It is perhaps in order then for me to add just a word or two about electric heating, which, under proper control, gives very satisfactory results, as is demonstrated by a catenary furnace now being used by the United States Steel Corporation. Moreover, the system of radiant tubes proposed is not without its difficulty. As I understand it, uniform temperature along the U tube depends on keeping a constant gas velocity in the tube. If adjustments must be made by the proportioning system suggested it seems to me that a temperature variation might appear.

In conclusion, lest I seem to have been overcritical of Mr. Keller's process, I hasten to add that I am not critical of his purpose but rather slightly skeptical as to the present stage of development of his process, and I sincerely hope that this development will continue.

AUTHOR'S CLOSURE

The care which Mr. Austin has given to preparing his discussion of the paper is much appreciated.

It may be well to state that the author does not consider the process described as being his own, since the combined efforts of a number of individuals have gone into its development.

Mr. Austin's discussion was written before he had available the appendix, describing the researches of Wallace and Rickett and of Pomp and Niebch. Most of the questions raised in his paragraphs 4, 5, and especially 6 are answered by their work. Both found that the lower limit of hardness, while not exactly reached, was approximated in less than 15 minutes' annealing time. Pomp and Niebch found this to be true of one of the kinds of steel tested, in specimens four times as thick as tin-plate stock, after only one to three minutes; and Wallace and Rickett found that, in most cases, any further softening occurred not after an hour or two but only after a long soaking period of the order of sixteen hours.

As to the exact means used for regulating the temper in continuous annealing, in the electrically heated furnace referred to, this is effected chiefly by varying the speed of the strip travel and in this way regulating the maximum temperature attained by the strip; the furnace temperature is held approximately constant within the limits of the on-and-off supply system of electrical current. Apparently no difficulty has been experienced in controlling the temper within close limits. In the gas-fired continuous furnace it is planned to keep the strip speed approximately constant and to control the temper of the strip by accurate control of the furnace temperature.

The author knows of no research on

quench-aging of continuously annealed strip material, but the can makers seem not to have found any objectionable characteristics in such material formed within a reasonable time after the continuous anneal.

Mr. Austin's conjecture, that one important reason why not more has been done along the line of developing the continuous annealing process is to be found in the fact that some modifications of present commercial practice and of the technique now used in later processing of the annealed material will be required when changing over to the continuous process, is quite correct. The required changes in technique appear, however, to be remarkably few and unimportant, and the supposed obstacle seems to exist chiefly as a state of mind rather than as a physical reality.

J. D. KELLER.[15]

[15] Associated Engineers, Pittsburgh, Pa.

"Dirt and Delay"

TO THE EDITOR:

A better title for the frontispiece of the October issue of MECHANICAL ENGINEERING entitled "Men and Machines for National Defense" would be "Dirt and Delay."

To say the least, I am greatly surprised that a magazine representing what is professed to be one of the foremost engineering societies should give prominence to a picture such as this which shows antiquated methods or sloppy and inefficient management. Certainly chips would not be allowed to accumulate like this around a machine in any well-regulated shop.

Beginning with page 697 of the same issue you publish an article on the new plant of the Wright Aeronautical Corporation in Cincinnati. Why not be consistent?

F. A. JIMERSON.[16]

[16] Mem. A.S.M.E.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Modern Metallurgy for Engineers

MODERN METALLURGY FOR ENGINEERS. A text and reference book on metals and alloys, by Frank T. Sisco. Pitman Publishing Corporation, New York, N. Y., 1941. Cloth, 6 × 9 in., 432 pages, 180 illustrations, diagrams, tables, $4.50.

REVIEWED BY J. J. KANTER[1]

ENGINEERS who find difficulty in these busy times in following the complex developments in the technology of metals and their alloys, will find Mr. Sisco's book a reliable source for clarification. The author's broad experience in the field of applied metallurgy together with his present capacity as editor of the "Alloys of Iron Monographs" uniquely qualified him to prepare a volume on modern metallurgy specifically for engineers. Although a number of other books to the same general purpose have appeared in the past, the general fast tempo of developments in metallurgy warrants frequent recapitulations available in a form understandable to the nonspecialist, and in this regard Mr. Sisco's presentation is indeed timely.

The twenty-one chapters of Mr. Sisco's book systematically cover the manufacture, compositions, structures, treatments, properties, and applications of the significant metallurgical products in both the ferrous and nonferrous fields. Enough theory is discussed to satisfy the general readers' or students' appetite and a good compilation of suggested references for further reading is given. Of special interest to designing engineers are the chapters treating of mechanical properties at both normal and elevated temperatures, corrosion and corrosion resistance, machinability, wear resistance, and deep-drawing properties. This book will give the student a basis for differentiation of the limitations and basis of selection of steels, cast irons, brasses and bronzes, and the light metals. In these times, where the engineer is constantly confronted with problems of metals substitutions, the reading of this book should prove helpful. Its reading is highly recommended for the many new inspectors of metal products created by defense activities. This book might well serve as a textbook in the metallurgy courses which many of our colleges and universities are currently offering in connection with defense-engineering curricula for the training of inspectors. An appendix of appropriate questions to each chapter makes for its convenient use as such a text.

In his preface, Mr. Sisco grades the chapters of his book as to their reading difficulty through a bar chart. This feature was introduced by the author to impress engineers that the book is prepared from the standpoint of imparting pertinent information rather than exercises in mental gymnastics. A book written upon this plan is indeed currently useful for the urgent and rapid dissemination of metals technology necessitated by the national emergency.

[1] Materials Research Engineer, Crane Co., Chicago, Ill. Mem. A.S.M.E.

Automotive Engine Testing

AUTOMOTIVE ENGINE TESTING, A Manual of Test Procedure. By Foster M. Gruber. Pitman Publishing Corporation, New York, N. Y., 1940. Cloth, 6 × 9 in., 441 pp., 240 figs., $4.75.

REVIEWED BY L. C. LICHTY[2]

THE author's object as indicated in the preface was to compile a very considerable amount of information useful for test and experimental engineers. This he appears to have done, the material ranging from the selection and qualifications of test engineers to cathode-ray-oscillograph circuits.

The introductory chapter gives a brief sketch of past design, which is followed by a good picture regarding future development of engines and the difficulties to be encountered. In the same chapter are found sections dealing with the reason for experimental testing and also the test engineer.

The second chapter entitled "Mechanical Principles" includes a short section on

[2] Associate Professor, Mechanical Engineering, Yale University, New Haven, Conn. Mem. A.S.M.E.

thermodynamics which contains the old and obsolete definition and use of the word "heat." The nonflow energy equation and the entropy equation for reversible processes only are presented. The section on combustion presents several erroneous ideas, one dealing with the thermodynamic loss entailed by the introduction of excess air to insure combustion, and another that "carbon in a typical fuel releases less heat than the hydrogen." Rich mixtures are erroneously thought to release all the hydrogen and this is supposed to account for greater thermal utilization. The pressure-volume diagram in this section illustrating the effect of increasing compression pressure on thermal efficiency is used in a not at all convincing manner. Only the air-standard treatment of the various cycles is presented, although curves of efficiency based on Hottel's work[3] are shown much later in the book; but no text reference to them was found.

Statements such as, "the fact that ignition occupies a finite time influences the valve opening period," are apt to leave the reader in a state of bewilderment.

The book is well-illustrated but unfortunately no reference is made to some illustrations. Some illustrations are outside views which are of questionable value, and very little indication is made of the source of the illustrations. In the case of engine cross sections and certain other illustrations, it would appear desirable to indicate the manufacturer of the apparatus not only for credit purposes but also for information to test engineers.

Much of the information found in this book is drawn from other sources, which broadens the scope of the book. However, in only a few places is the source of information indicated and in the rest of the book the reader must be well informed on the original sources to be able to suspect the origin of the material.

The sections dealing with testing, test equipment, analysis, and trouble segregation are the parts of most interest to the test engineer. While the text for these parts refers principally to aircraft-engine practice, it is applicable also to all other types of engines.

The discussion of the various factors which influence engine performance is a well-balanced theoretical and practical treatment. However, the part dealing with energy distribution erroneously includes the work of friction in the distribution of energy. The energy loss to the coolant is presumably measured and contains a part of the energy dissipated by friction. The other part of the friction energy should be included with the exhaust-energy term.

No attempt is made to show the development of all the formulas, it being assumed that the book is more of a handbook than a text. Here again reference to the source of the formulas would be valuable to the test engineer who might wish to know the assumptions used in setting up the relationship.

The appendix contains a list of 900 questions, divided into groups referring to the various 13 chapters in which information is given to answer the questions. These questions should provide an excellent incentive to those interested in broadening their knowledge to study the book.

A bibliography containing a list of 81 books, 82 research reports, and 240 technical papers is also found in the Appendix. A list of 38 National Bureau of Standards publications dealing with fuel research is added. The bibliography is arranged alphabetically according to author rather than classified according to subject material. The dates of publication of some of the books are omitted. The delay between submission of manuscript and date of publication (1940) of the book probably accounts for the omission of some late worth-while books but one wonders why some are omitted and other early books now obsolete are included.

On the whole there is much worthwhile material, well treated in the field of testing, which makes the book a desirable one for test engineers.

[3] "Thermodynamic Properties of Working Fluid in Internal-Combustion Engines," by R. L. Hershey, J. E. Eberhardt, and H. C. Hottel, *S.A.E. Journal* (Transactions Section), vol. 39, no. 4, October, 1936, pp. 409–424.

Machine-Shop Practice

NEW ENCYCLOPEDIA OF MACHINE-SHOP PRACTICE. Edited by George W. Barnwell, Wm. H. Wise and Co., Inc., New York, N. Y., 1941. Semiflexible cloth, $5^5/_8 \times 8^3/_8$ in., 576 pp., $1.98.

REVIEWED BY CHARLES L. TUTT, JR.[4]

THE National Defense Program has greatly increased the number of apprentices in the machining industries and the number of semiskilled workers being upgraded to fill positions in the skilled-mechanic category. Hence an inexpensive encyclopedia of machine-shop practice makes a timely appearance.

In the past most books dealing with machine-shop practice have described specific problems or have been of value chiefly for teaching apprentices machine-tool operation. The present encyclopedia describes briefly many complexities of the machinist's craft in such a way that any man with even a brief shop experience can greatly increase his knowledge and comprehension of tools, terms, machines, methods, and measuring instruments. With the exception of the field of broaching, in which advances have been rapid, it appears to be up to date. The number, uniformity, and excellence of the illustrative sketches are to be commended.

[4] Assistant Professor of Mechanical Engineering, Princeton, University, Princeton, N. J. Jun. A.S.M.E.

Salary Determination

SALARY DETERMINATION. By John W. Riegel, University of Michigan Press, Ann Arbor, Mich., 1940. Cloth, 6×9 in., 278 pages, $3.50; paper, $3.

REVIEWED BY HAROLD B. BERGEN[5]

HERE is an outstanding discussion of the common policies and selected practices in forty American companies relative to salary determination. This material is presented in logical sequence, including essentials of salary policy, salary surveys, standard salaries for key positions, bases for valuing uncommon positions of a routine nature, position analysis, standard salary ranges, compensating the individual, incentive plans, valuation of managerial and technical services, and salary adjustments. This book should be in the office library of every executive responsible for the establishment of salary schedules and the authorizing of salary adjustments.

The unique contribution of the book is its practical combination of methodology with philosophy. Concrete examples are given which should prove helpful not only to executives but also to technical specialists in salary administration. And the fundamental principles underlying the application of techniques are explored fully and lucidly.

The author's style is most readable, and not at all pedantic. The so-called practical executive will find the book both interesting and instructive. On the other hand, the technician will find much material to study carefully.

The weaknesses of the book are few and far between. Perhaps the major deficiency is some absence of adequate definitions and some confusion in terminology. For example, the author defines a "position" as "any organization unit to which duties and responsibilities are delegated for performance by one employee," and then proceeds to use the term to designate what to your reviewer appears to be "class of positions."

[5] Partner, McKinsey & Company, Management Consultants, New York, N. Y., and Boston, Mass. Associate A.S.M.E.

Another weakness is the lack of reference to the pioneer work done in this field in the 1920's (1) in the public service by such authorities as Griffenhagen and Telford, and (2) in private industry by members of the salary-administration group of the American Management Association. Most of the author's selected references and acknowledgments refer to more recent work by individuals little known a decade ago.

These weaknesses, however, are minor, and detract but little from the distinct practical contribution of the book to the art of salary administration.

Books Received in Library

ATM (Archiv für technisches Messen), Lfg. 119, May, 1941. By R. Oldenbourg, Munich and Berlin, Germany, pp. T63–T77, F3; paper, $8^1/_2 \times 12$ in., illus., diagrams, charts, tables, 1.50 rm. This monthly publication contains classified articles upon various types of apparatus and methods of technical measurement. There are also descriptions of specific instruments manufactured by German companies.

AEROSPHERE, 1941, including Modern Aircraft, Modern Aircraft Engines, Aircraft Statistics, Buyer's Guide. Edited by G. D. Angle. Aircraft Publications, New York, N. Y., 1941. Cloth, $8^1/_2 \times 12$ in., 948 pp., illus., diagrams, tables, \$10. In this second edition the historical section describing the world's aircraft engines of all time has been omitted and will henceforth be available in a separate volume. The construction, performance, and characteristics of all current types of aircraft and aircraft engines are given in the first two sections. Statistics, records, and other useful data are included in the third section. A buyer's guide, containing first an alphabetical list of firms for each country, and second a product directory by countries, completes the volume. Hundreds of photographs and cross sections accompany the descriptions.

AIRCRAFT ENGINES, Vol. 2. By A. W. Judge. D. Van Nostrand Co., Inc., New York, N. Y., 1941. Cloth, $5^1/_2 \times 9$ in., 446 pp., illus., diagrams, charts, tables, \$9. The theoretical and experimental aspects of aircraft engines having been covered in volume 1, the present volume is devoted principally to detailed descriptions of a large number of representative engines from various countries. Certain design and theoretical considerations concerning lubrication, ignition and exhaust systems, torque and balance, and other topics not previously dealt with are also included.

AIRCRAFT MECHANIC'S POCKET MANUAL. By J. A. Ashkouti. Pitman Publishing Corporation, New York, N. Y., and Chicago, Ill., 1941. Cloth, $5 \times 7^1/_2$ in., diagrams, tables, \$1.50. Prepared for the man in the shop, this manual contains basic data on aircraft production. Pattern layout, materials, finishes, tools, tolerances, and standard parts approved by the Army and Navy are covered in separate sections. Aircraft identification standards and a large glossary of aeronautical terms are also included.

AIRCRAFT TEMPLATE DEVELOPMENT, compiled and edited by Aero Publishers, Inc., Aero Publishers, Glendale, Calif., 1941. Cloth, $6 \times 9^1/_2$ in., 312 pp., illus., diagrams, charts, tables, \$4. Fundamental principles involved in the developing and making of aircraft templates are presented in this comprehensive, practical textbook for students, apprentices, and trainees. There is a large section of sample problems, including blueprints and suggested procedures. A brief glossary is appended.

DAVISON'S TEXTILE BLUE BOOK, United States, Canada, and Mexico. Seventy-Sixth Year, July, 1941. Handy edition, Davison Publishing Co., Ridgewood, N. J. Fabrikoid, 5×8 in., 1200 pp., maps, \$5. This annual publication lists geographically manufacturers of cotton, woolen and worsted, silk and rayon, and knit goods; dyers and finishers; commission merchants, dealers, and importers; domestic and foreign raw-cotton firms; and other groups useful to the trade. There are two special lists of pertinent associations and railroads serving the various mills, and an alphabetical index to mills and dyers is included.

DESIGN HANDBOOK FOR PRACTICAL ENGINEERS. By A. Cibulka. Apply to author, Dr. Alois Cibulka, Baytown, Texas, 1941. Paper, 9×12 in., diagrams, charts, tables, \$10; reduced price in lots of 3 or more. The five parts of this compilation of design data and formulas cover, respectively, strength of materials, steel and concrete structures; pressure and vacuum vessels, piping and metals; hydraulics and heat transfer; mathematical tables and general engineering formulas. Most of the material is in the form of tables and charts, with such explanation as is considered necessary.

DRILLING EQUIPMENT DIRECTORY 1941-1942, published every two years by Petroleum Directory Publishing Co., affiliated with the *Oil and Gas Journal*. Petroleum Directory Publishing Co., Tulsa, Okla., 1941. Fabrikoid, $8^1/_2 \times 11$ in., paged in sections, illus., diagrams, charts, tables, \$10. The special feature of this biennial directory is the several hundred pages of classified practical engineering, A.P.I., and reference data, with each section of which is included the advertisements of related manufacturers. A complete classified buyers' guide lists all companies offering equipment or services required in the drilling of oil and gas wells.

ELEMENTS OF ENGINEERING THERMODYNAMICS. By J. A. Moyer, J. P. Calderwood, A. A. Potter. Sixth edition rewritten. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, London, England, 1941. Cloth, $6 \times 9^1/_2$ in., 217 pp., diagrams, charts, tables, \$2.50. In the present edition, as in the previous ones, this book is designed to stress the fundamental principles of engineering thermodynamics as a foundation for the more advanced and practical applications of the theory. It is intended particularly for use in technical colleges having special courses in advanced thermodynamics, steam turbines, internal-combustion engines, heating, refrigeration, and other applications of thermodynamics.

ENGINEERING DESCRIPTIVE GEOMETRY AND DRAWING. By F. W. Bartlett and T. W. Johnson. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, Ltd., London, England, 1941. Cloth, $6 \times 9^1/_2$ in., 572 pp., illus., diagrams, charts, tables, \$4.50. This comprehensive textbook, developed for use at the U. S. Naval Academy, consists of three parts: 1, Line drawing, which is chiefly concerned with the manner of handling the instruments; 2, engineering descriptive geometry, which deals with the rules of orthographic projection applied to simple geometrical shapes; and 3, engineering drawing, which describes the application of the general principles of drawing to engineering purposes with emphasis on detail drawing.

ENGINEERING ENCYCLOPEDIA, 2 volumes, edited by F. D. Jones. Industrial Press, New York, N. Y., 1941. Fabrikoid, $6 \times 9^1/_2$ in., 1431 pp., diagrams, charts, tables, \$8. This two-volume reference work supplies such practical and useful information as the various important mechanical laws, rules, and principles; physical properties and compositions of a large variety of materials used in engineering practice; the characteristic features and functions of different types of machine tools and other equipment. The 4500 topics included are alphabetically arranged and cross indexed for convenient reference, and have been selected for their usefulness in the mechanical industries.

HEAT ENGINES, Steam, Gas, Steam Turbines and Their Auxiliaries. By J. R. Allen and J. A. Bursley. Fifth edition, McGraw-Hill Book Co., Inc., New York, N. Y., 1941. Cloth, $6 \times 9^1/_2$ in., 576 pp., illus., diagrams, charts, tables, \$4. The essential principles of steam engines, boiler plants, internal-combustion engines, steam turbines, and their auxiliaries are presented in this introductory textbook. In the present revision particular attention has been given to boiler auxiliaries, steam turbines, and the internal-combustion engine. There is also included a new chapter devoted to air compressors and refrigerating machinery.

HOTEL ENGINEERING, vol. 2. Electric Current Consumption, Costs and Savings. By G. C. St. Laurent. American Hotel Association of the United States and Canada, New York, N. Y., 1941. Paper, $8^1/_2 \times 11$ in., 43 pp., tables, \$1.50. This booklet is the second in a series of four covering important subjects of hotel engineering, of which the first, published in 1940, dealt with water consumption, cost, and savings. The present issue covers hotel electric problems and trends, and discusses ways of saving electric current. Considerable statistical data are included in tabular form.

IMPACT RESISTANCE AND TENSILE PROPERTIES OF METALS AT SUBATMOSPHERIC TEMPERATURES; prepared by H. W. Gillett, Project No. 13 of the Joint A.S.M.E.-A.S.T.M. Research Committee on Effect of Temperature on the Properties of Metals, August, 1941; authorized reprint from Proceedings of American Society for Testing Materials, Philadelphia, Pa. Board, 6×9 in., 112 pp., diagrams, charts, tables, \$2.50. This report contains information and data collected from laboratories interested in low-temperature work. Much of the material is in tabular form for convenience. There is a full discussion of impact resistance, followed by impact data for both ferrous and nonferrous materials, and some fifteen pages relate to low-temperature tensile properties. There is a bibliography.

MACHINE SHOP TRAINING COURSE, 2 volumes. By F. D. Jones. Second edition. Industrial Press, New York, N. Y., 1941. Vol. 1, 538 pp.; vol. 2, 552 pp.; fabrikoid, $6 \times 9^1/_2$ in., illus., diagrams, charts, tables, vols. 1 and 2, \$6; either volume separately, \$4. Especially designed for shop courses, vocational schools, and self-instruction, this treatise covers fundamental principles, methods of adjusting and using different types of machine tools, measuring instruments and gages, screw-thread cutting, thread grinding, gear cutting, and precision toolmaking methods. The chapter subheadings are in the form of questions which are answered in a practical manner, with typical examples. There is a large glossary with full definitions, and the new edition contains as well a chapter on blueprint reading.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

National Defense and Postwar Planning Keynotes of A.S.M.E. Wood Industries and 1941 Fall Meeting, Louisville, Ky., Oct. 12–15

NATIONAL defense and planning for postwar conditions were the central themes running through the papers and addresses featured at the 1941 Fall Meeting, Louisville, Ky., October 12 to 15, of The American Society of Mechanical Engineers, with which was merged the 1941 Annual Meeting of the A.S.M.E. Wood Industries Division. With headquarters at the Hotel Brown and showered with the gracious hospitality of the A.S.M.E. Local Section, the 300 members and guests registered for the convention enjoyed a varied program of technical sessions, plant visits, and social events that did credit to the local and Society committees that arranged the program.

Council and Section Delegates Meet

On Sunday the Executive Committee and members of the Council met for the consideration of Society business that will be reported later. Simultaneously the Standing Committee on Local Sections and the Local Sections Group VI delegates convened for discussion of their problems. Members of all of these groups lunched together Sunday noon and were joined by Louisville members and early registrants at a buffet dinner on Sunday evening.

Social Events Reflect Louisville Hospitality

Throughout the convention women guests with their Louisville hostesses enjoyed a special program of sight-seeing which concluded on Wednesday afternoon. The high light of this program was a horse show and barbeque which was attended by as many of the men as were able to stay over to enjoy it. Louisville's finest horses competed in the show for prizes offered by the Louisville Section.

Scheduled plant visits, supplemented by numerous unscheduled ones, afforded opportunity for inspection of numerous points of interest in the Louisville district. Among these were the Axton-Fisher Tobacco Company, the Brown-Forman Distillery, the American Air Filter Company, Churchill Downs, Jos. E. Seagram and Sons' newest and largest distillery, and generating stations of the Louisville Gas and Electric Company.

Throughout the convention a display of ordnance matériel, in charge of the Cincinnati Ordnance District, was on exhibition in the lobby of the hotel and excited continual interest.

Technical Sessions Include Wood-Industries Papers

The technical program consisted of 17 sessions at which 33 papers were presented, and two luncheons and a dinner at which there were nine addresses in all. A number of the papers have already appeared or will eventually appear in the Society's publications, MECHANICAL ENGINEERING and the Transactions. Mimeographed copies of many papers received too late for preprinting are also available. Papers covered a wide variety of subjects including tobacco, furnace and superheater design, design and performance of molded parts, synthetic rubber, shell forging, induction heating, industrial hygiene, aluminum manufacture and processing, air filters, drying, national-defense plants, visual aids for defense training, shrinkage and swelling of wood, modern timber-construction methods, the Watts Bar steam station, estimating circulation in boiler-furnace circuits, resin adhesives and resin treatment of wood, the 1937 Louisville flood, turbines operating on industrial-process gases, smoke abatement, depreciation, shell machining with carbide tools, arsenal work in industrial plants, ice manufacture, the Girbotol process, urea treatment of lumber, edge gluing of lumber and veneers, and corrosion of steel and various alloys by high-temperature steam.

Mr. Hanley Speaks on Today and Tomorrow

The Engineers and Architects Club of Louisville participated in the luncheon on Monday noon at which F. L. Wilkinson, Jr., general vice-chairman of the meeting, presided. The Hon. Joseph D. Scholtz, Mayor of Louisville, welcomed members of the Society to the city. He spoke of some of the problems of city administration created by an influx of new inhabitants, of the defense plants and Army camps of the district, and of his interest in smoke abatement.

Mr. Hanley's subject was "National Defense Today and Tomorrow." This subject, he said, had to do with two problems which we were facing—one an immediate and the other a future problem. Problem No. 1 was the winning of the war. In his opinion we were already in the war regardless of what we might think of the situation, and he cited as evidence such factors as the turning over to the British of overage destroyers, the Lend-Lease Bill, and the repair of British warships in our Navy yards. He called for unity of the people of the nation to uphold the President and the Congress.

Among the engineers serving in Washington Mr. Hanley mentioned four A.S.M.E. past-presidents, Batt, Flanders, Kimball, and McBryde, and the Society's secretary, C. E. Davies. He called on engineers to be realists, to realize that sacrifices must be made, to understand the necessity of such measures as the dedication of plants to the national defense, priorities, and the conservation of raw materials, and to assist the public in acquiring an appreciation of these matters in the cause of national unity. Reviewing the errors made by France and other nations in underestimating the strength and intentions of Hitler, he called upon Americans not to repeat them and to realize that the alternative to defeating Hitler was to be defeated by him. There could be no draw. To this task, he said, the engineering profession had already dedicated itself.

Postwar Problems Outlined

Turning to the second phase of his subject, postwar conditions, Mr. Hanley said that we must be thinking and planning now what to

Program and News of the

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will be found in the Special Insert Section, pages 846–854

do when the war would be over. It would be a calamity, he asserted, to win the war abroad and lose it at home. We must, he insisted, carry on our way of life, and for this purpose national unity must hold. Pointing out that within two years 23 million workers would be engaged in defense activities, he posed the problem of what to do with these persons when peace should return. There was, he said, a drift toward the socialized state, a form of society we did not wish to see prevail in this country. Leaders must be found to think out and solve the problems which, if left unsolved, would lead to social upheaval.

Engineers should give serious thought also, Mr. Hanley said, to the subject of debt and fiscal policy. That we should go still further into debt as a nation was evident, and a figure of $125 to $150 billion, which was easily possible, afforded engineers a problem to think about. Dictators, he recalled someone as saying, were the receivers of bankrupt republics. It was obvious that we would never get back the money expended under the Lend-Lease Bill because our debtors would be unable to repay it. It was therefore necessary to devise sound measures for arranging our internal economy, as otherwise we would find someone else in the driver's seat. We could not continue the policy of deficit spending after the war and hence would be forced to adopt a "pay-as-we-go" policy.

In closing he stated that it was our desire for our children to carry on under the system of free enterprise we had enjoyed and the government that had been established by Washington and Jefferson. "If we win the war," he said, "and if we can meet the postwar problems that will confront us, we shall be able to pass on our economic system and our form of government to future generations and we shall not have fallen down."

Free Enterprise Upheld

At the Management Luncheon on Tuesday noon, Melvin Sack, general chairman of the Fall Meeting, presided and Walter White, assistant to the chairman of the Business Advisory Council for the Department of Commerce, Washington, D. C., delivered an address, "Free Enterprise and World Politics," which was broadcast over station WAVE. He said in part:

"Capitalism and the profit motive are inseparably entwined with the institution of free private enterprise. Collectivism in any form, whether by state ownership or by state domination and regulation of daily business transactions, is the antithesis of free enterprise.

"You are all certainly aware of the political developments of recent years as a result of which the areas where free private enterprise continues to exist have progressively shrunken. . . . . In the Scandinavian countries and to some extent in Great Britain free enterprise has for years been subjected to a gradual socialization whose counterpart under an accelerated program during the past eight years in this country is deemed by some business and professional men to be nothing less than rampant radicalism.

"France represents the feeble effort of one democracy to compromise social objectives of the masses with the preservation of capitalism.

"In our own country we have witnessed a consistent and accelerated encroachment of the state of the freedom of private enterprise . . . . There is today in the minds of most of our citizens a conviction that unless the free enterprise system satisfies the basic social needs of the individual and of the community, then the government must do the job . . . . And so, as a result of World Politics of a revolutionary character, on top of a natural evolutionary movement, free enterprise as the main spring of social and economic progress hangs in the balance.

"Lest you think of me only as a dreadful apostle of gloom, let me say that I regard the situation as a challenge and an opportunity rather than as an inexorable fate . . . . Under the defense program private industry is meeting a severe test. Will management have the wisdom to put aside temporary advantages in favor of its future existence? Personally, I think it will if business leaders read the public mind correctly and are ready to make the necessary sacrifices and adjustments. But this will not be enough. When the military phases of the war are over, an even severer test will come. How will we then keep men employed and sustain purchasing power in converting military production to civilian needs? The wisdom and the genius of engineers, research scientists, and economists are needed not only to plan ahead for this inevitable day but to put those plans into effect. Business management must prepare itself to meet this test, for if it does not, then public agencies will take over those functions of production and distribution necessary to provide jobs and goods. . . .

"If the reforms which can be foreseen are not carried too far, if our business statesmanship can adjust itself to the new order without cracking, and if our political leadership really wants to preserve a modified private enterprise system, then we may look forward with hope to very much better days. . . .

"You may ask me: What can those who have an interest in the free enterprise system do about its preservation?

"First of all, you can preach among your associates and clients the need for adjustment to the trend of the times and the wisdom of a realistic answer to this pressure from the masses for social and economic improvement and for more equal opportunities to enjoy the better things of life . . . . Your second opportunity to help preserve private enterprise is in the field of politics. Politicians, with few exceptions, are responsive to what they believe their constituents want, regardless of their personal convictions . . . . The advocates of the private enterprise system either do not think that its defense is necessary or they seem to lack the initiative to organize for political action.

"And so my final suggestion to you as individuals and as an organization is that you devote some of your time and talents to political engineering. Get to know your congressman and your senators personally. Find out what their problems are so that when you discuss your own views you will know how best to answer the arguments of other constituents."

What's New in the Wood Industries

One of the high lights of the 1941 Fall Meeting was the dinner on Tuesday evening at which the program of addresses had been arranged by the A.S.M.E. Wood Industries Division. Melvin Sack presided and introduced the toastmaster, Foster Gunnison, president, Gunnison Housing Corporation, New Albany, Ind. A symposium on wood and plywood in the defense program followed which consisted of six ten-minute addresses of excellent quality.

"Aircraft Requirements From the Plywood Industry," by S. Paul Johnston, research coordinator, National Advisory Committee for Aeronautics, Washington, D. C.

"Lumber in the Defense Program," by Richard G. Kimbell, director of technical services, National Lumber Manufacturers Association, Washington, D. C.

"Plywood in Boat Construction," by James J. Dunne, vice-president, U. S. Plywood Corporation, New York, N. Y.

"Woodworking Machinery for Defense," by Armen S. Kurkjian, Oliver Machinery Company, Grand Rapids, Mich.

"Forest Products Laboratory Program," by A. J. Stamm, Forest Products Laboratory, Madison, Wis.

"Service of the Wood Industries Division of the A.S.M.E.," by Charles B. Norris, chairman of the division, and director of research, Merritt Engineering and Sales Company, Lockport, N. Y.

Louisville Committees Make Meeting a Success

The success of the Louisville meeting was largely the result of the efforts of the local committees under the leadership of Melvin Sack, general chairman, and Ford L. Wilkinson, Jr., general vice-chairman. The committees consisted of the following:

Technical Events: Howard C. Murphy, chairman, V. C. Blackman, C. D. Eldridge, and George W. Hubley.

Plant Trips: Norman W. Cummins, chairman, Julius Credo, John F. Hurst, Richard W. Leins, and Lester S. O'Bannon.

Entertainment: William F. Lucas, chairman, F. W. Hampton, and G. D. Whiting.

Publicity: Henry V. Heuser, chairman, and Otto C. Krause.

Hotel: John H. Romann, chairman, David L. Whitherspoon, and Wm. David Wuest.

Printing and Signs: H. H. Fenwick, chairman, and Dale C. Graffee.

Reception: Ford L. Wilkinson, Jr., chairman, Harley R. Crull, John M. Graham, T. W. Samuels, Wm. S. Speed, and L. R. Stutz.

Finance: John K. Meyer, chairman, Elmer J. Dreyer, and Lewis R. Jackson.

Registration and Information: Ralph S. Trosper, chairman, W. B. Buckle, Robert D. Hawkins, J. E. Glass, Harold Haight, Wm. J. Riester, J. Kirk Rowell, Francis P. Shannon, and Howard A. Wilson.

Horse Show Promotion Director: Elmer J. Dreyer.

Women's Events: Mrs. F. P. Shannon, chairman, Mrs. N. W. Cummins, Mrs. E. J. Dreyer, Mrs. C. D. Eldridge, Mrs. H. V. Heuser, Mrs. G. W. Hubley, Mrs. L. R. Jackson, Mrs. R. W. Leins, Mrs. W. F. Lucas, Mrs. J. K. Meyer, Mrs. Lucio Mondolf, Mrs. H. C. Murphy, Mrs. J. H. Romann, Mrs. Melvin Sack, Mrs. L. R. Stutz, Mrs. R. S. Trosper, Mrs. D. L. Whitherspoon, and Mrs. F. L. Wilkinson, Jr.

Actions of A.S.M.E. Executive Committee

At Meeting in Society Headquarters on September 16

THE Executive Committee of the Council of The American Society of Mechanical Engineers met in New York on Sept. 16, 1941. There were present William A. Hanley, chairman; Kenneth H. Condit, vice-chairman, Clarke Freeman, K. M. Irwin, of the Committee; Jos. L. Kopf (Finance), J. N. Landis (Local Sections), Victor Wichum (Professional Divisions); James W. Parker; C. E. Davies, secretary; and Ernest Hartford, executive assistant secretary. Actions of general interest were as follows:

Engineers' Defense Board

The Committee voted to participate in the activities of the recently organized Engineers' Defense Board (see page 840 of this issue). A.S.M.E. representatives on the Board were named as follows: K. H. Condit, H. V. Coes, R. M. Gates (representative on executive committee of the Board), J. W. Parker, and W. R. Webster.

Dues of Members in Special Classifications

The Society's present policy of suspension of dues for foreign members who are unable to secure permits for currency exportation and of members inducted into government service (noncommissioned officers or lower rank) without loss of membership but with suspension of publications was extended to Sept. 30, 1942. Acceptance of 1941-1942 dues from Canadian members in Canadian exchange when payments are received on or before Dec. 1, 1941, was also extended.

Charges for Preprints of Papers

Approval was voted, on recommendation of the Board on Technology, of charging for preprints of papers delivered at meetings, and the Board was authorized to set up a schedule of prices.

The Board on Technology was authorized to increase its membership by the addition of a representative of the Committee on Local Sections.

Appointments

The Committee approved the appointment of Edward R. Granniss to represent the Society, at the invitation of the National Safety Council, "in a nation-wide and continuing campaign against accidents of all kinds that are hampering the National Defense Program;" and of William L. Batt, to serve a term expiring in 1942, representing the Society on the Division of Engineering and Industrial Research of the National Research Council.

The following appointments to standing and special committees and Society representatives were reported:

Finance Committee, Elmer Grimmett (3 years, replacing W. I. Slichter); Professional Divisions, W. M. Sheehan (4 years); Economic Status of the Engineer, Harry Ritterbusch (Junior Member of Committee); Board on Technology, C. B. Peck (J. C. Hunsaker's unexpired term); Tellers of Election, W. H. Boehm, W. N. Dickinson, and E. H. Neff; Special Research Committee on Fluid Meters, E. W. Jacobson; P. T. C. Committee No. 20, Speed Temperature and Pressure Responsive Governors, C. L. Avery; Joint A.I.E.E.-A.S.M.E. Committee on a Specification for Governing Devices of Prime Movers Driving Electric Generators, C. L. Avery, R. J. Caughey, Herbert Estrada, A. F. Schwendner, and C. Richard Soderberg; Daniel Guggenheim Board of Award, E. E. Aldrin (3 years); Washington Award Commission, Arthur L. Rice (1 year) and Will J. Sando (2 years); Marston Medal Board, W. L. Abbott (4 years); Conference on Science, Philosophy, and Religion, New York, Sept. 8-12, Geo. A. Orrok.

A.S.M.E. Calendar

of Coming Meetings

October 30–November 1, 1941
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions
Lafayette College
Easton, Pa.

December 1–5, 1941
Annual Meeting
New York, N. Y.

March 23–25, 1942
Spring Meeting
Houston, Texas

June 8–10, 1942
Semi-Annual Meeting
Cleveland, Ohio

(For coming meetings of other organizations see page 50 of the advertising section of this issue)

Jerome C. Hunsaker Elected Chairman, N.A.C.A.

THE National Advisory Committee for Aeronautics has announced the resignation of Dr. Vannevar Bush as chairman and the election of Dr. Jerome C. Hunsaker, member A.S.M.E., as chairman of the committee to succeed Dr. Bush.

Dr. Bush, who is president of the Carnegie Institution of Washington, resigned as chairman of the N.A.C.A. because of his recent appointment by the President as director of the newly created Office of Scientific Research and Development and because of the President's desire that he concentrate attention on his new duties.

The committee also announced the resignation of Dr. Robert E. Doherty as a member of the committee and the appointment by the President of Dr. William F. Durand, past-president A.S.M.E., to succeed Dr. Doherty.

D. Robert Yarnall to Be Hoover Medalist

ANNOUNCEMENT has been made that D. Robert Yarnall, mechanical engineer of Philadelphia, Pa., has been selected as the fifth recipient of the Hoover Medal. The Medal will be presented to Mr. Yarnall during the Annual Meeting of The American Society of Mechanical Engineers in New York City, December 1–5, 1941, with the following citation:

"D. Robert Yarnall, humanitarian, engineer, and a leader in the engineering profession, who rendered outstanding service as a member of a mission that fed the children of Germany at the end of the World War and that is now aiding refugees in this country and Europe and providing food and relief for the children and mothers of France. These distinguished public services have earned for him the Hoover Medal for 1941."

Edwin H. Colpitts to Head Engineering Foundation

EDWIN H. COLPITTS has been appointed Director of The Engineering Foundation effective October 1, 1941, succeeding the late Dr. Otis E. Hovey.

Established in 1914 by a gift of the late Ambrose Swasey, The Engineering Foundation's purpose is "the furtherance of research in science and engineering and the advancement in any other manner of the profession of engineering and the good of mankind." The Foundation is a joint corporate agency of the four major engineering societies, namely, the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

To the directorship of The Engineering Foundation Dr. Colpitts brings a wide experience in the physical sciences and in engineering. After graduate study at Harvard in mathematics and physics he entered the Bell Telephone System in 1899, where he soon played an important part in the development and research work through his technical contributions and through his ability to supervise and stimulate the work of others. After several years in the American Telephone and Telegraph Company he served as assistant chief engineer of the Western Electric Company in charge of development and research work. In 1924 he became assistant vice-president of the American Telephone and Telegraph Company; and from 1933 to his retirement in 1937 he was vice-president of Bell Telephone Laboratories.

Dr. Colpitts, an LL.D. of Mount Allison University, is a Fellow in the American Institute of Electrical Engineers, the Institute of Radio Engineers, the American Physical Society, and the Acoustical Society of America.

Among the Local Sections

Anthracite-Lehigh Valley Meeting on Steel Casting

AT its first meeting of the 1941-1942 year, which was held in Pottsville, Pa., on Sept. 26, the Anthracite-Lehigh Valley Section presented E. M. Schumo, vice-president of the Pennsylvania Steel Casting Co., who spoke on "Design of Steel Castings." In his talk to the 76 members and guests, he explained how best results can be obtained when the machine designer works in conjunction with the foundry, especially if complicated castings are involved.

Safety in Defense Subject of Buffalo Section Session

Bringing out the fact that the lost-time cost through accidents to workers in 1940 came to $3,500,000,000, W. F. Stern, in a paper presented before the Buffalo Section on Sept. 23, pointed out the importance of safety in the National Defense Program and the increased activities incident to it.

Central Illinois Starts Season Off With Party

The members of Central Illinois Section started the 1941-1942 year of meetings off on Sept. 26 with a "curtain raiser" party at the Pabst Brewing Co. in Peoria, Ill. Needless to say, everyone had a good time.

G. F. Nordenholt Talks Before Cleveland Section

The Cleveland Section held a meeting on Oct. 9 which was addressed by G. F. Nordenholt, chairman of the Machine Shop Practice Division of the A.S.M.E. A great deal of interest was shown in his paper, which was entitled "Metal Substitutes for Materials and Uses of Plastics."

Los Angeles Sponsors Shipbuilding Program

More than 200 engineers took part in the Sept. 19 program of the Los Angeles Section which included a visit to the Wilmington shipyard of the California Shipbuilding Corporation and a dinner at the California Yacht Club followed by a lecture on "California Shipbuilding Corporation's Part in the Maritime Commission Program," by J. H. Wadsworth. The conducted tour of the shipyard included an inspection of the shipways, outfitting docks, assembly skids, plate and structural shop, machine shop, pipe shop, and mold loft. After the lecture, Rene DeVaranne, construction engineer of the corporation, answered the many questions asked from the floor.

Lakes and Fish Discussed at North Texas Meeting

J. K. G. Silvey was the guest speaker at the Sept. 23 meeting of the North Texas Section in Dallas. He discussed the fertility of lakes, the growth of plant life in them, the desirable types of fish for lakes and reservoirs, their habits, and the conditions which limit their size.

Maxwell C. Maxwell Addresses Plainfield

That authority on "loxology," Maxwell C. Maxwell, opened his 1941-1942 series of talks to A.S.M.E. Local Sections on Sept. 30 before the Plainfield Section. To the 50 engineers he exhibited large mechanical replicas of locks as used by the Egyptians, Romans, medieval Europeans, early Americans, and moderns. A sound motion picture entitled "Home Defense" was also shown.

Philadelphia Engineers Club Directory

A COMPREHENSIVE directory of engineers in metropolitan Philadelphia has been issued by The Engineers Club, 1317 Spruce Street, Philadelphia, Pa. Called "Who's Who in Engineering in Metropolitan Philadelphia," the directory contains an alphabetical list of engineers in that district, with addresses. Membership in The Engineers Club, the ten affiliated engineering societies, and eight nonaffiliated engineering-society groups is indicated by stars opposite each name in appropriately headed columns. The directory is supported by advertising, and a copy is provided free to each listed member of the club and its affiliated societies.

Rock River Valley Visits Grinding-Machine Plant

The first affair held this year by the Rock River Valley Section was a visit on Sept. 18 to the Charles H. Besly Company, manufacturers of screw taps and a variety of precision grinding equipment. Ralph Young and Kenyon Taylor explained the various manufacturing operations involved and some of the applications of the finished products.

Defense Vitamins and Incentives for San Francisco Engineers

E. H. Cameron, secretary-treasurer of the San Francisco Section, reports his group's meetings in a colorful and unique manner. For example, here are a few extracts from his report describing the Sept. 25th affair. "The formal opening of the fall session of activities . . . was particularly impressive. The smoothness with which all details of the meeting were efficiently consummated, from the planning of a dinner packed with vitamins to the quips by the speakers on the subject matter (Defense Vitamins for the Engineer) presented, proved an accelerating influence to all (70) present . . . Dean Samuel B. Morris, dean of engineering, Stanford University, outlined how the U. S. Office of Education was endeavoring to cooperate with industry in the defense program . . . through the Engineering Science and Management Defense Training Program . . . The courses presented aid the engineer in brushing up on fundamentals and in securing special training they have found essential to meet the new duties arising out of the Defense Program and expansion . . . J. Kadushin, supervisor of engineering training, Lockheed Aircraft Corporation, explained the means and ways developed by the aircraft industry in 'upgrading' employees . . . Upgrading comes to those who best qualify, thus an opportunity is afforded to the ambitious, the studious, and the ingenious. . . Thus we had a picture of two extremes, the search for knowledge by the underprivileged and the desire of the graduate student for practical application of his art and science . . . 'The die is cast,' we're off on a good start . . . San Francisco has lived up to its world-famous slogan, 'San Francisco Knows How!' "

Western Massachusetts Joins in Arms Meeting

The annual joint meeting of the Engineering Society of Western Massachusetts and the Western Massachusetts Section of the A.S.M.E. was held in Springfield, Mass., on Sept. 16. Col. Frederick H. Payne, chief of the Hartford Ordnance District, spoke on "New England Arms Makers—1941," and Brig.-Gen. G. H. Stewart, commanding general of the Springfield Armory, talked on "The Contribution of Springfield Armory to National Defense." In summing up his remarks, Colonel Payne concluded that our arms program is sound, industry is doing a good job, and the New England arms makers will meet the emergency as they always have. General Stewart traced the history of the Armory, including its development of the Springfield and Garand rifles. In closing he said, "Springfield Armory now, as always, manufactures the best, the surest, and the most effective rifles that American genius can produce."

Get-Together Smoker Opens West Virginia Section Year

The first affair of the 1941-1942 year for the West Virginia Section consisted of an informal smoker and get-together on Sept. 23. About 60 members and their guests attended and partook of the beer, cheese, crackers, and cigars. Three short one-reel motion pictures were shown. They included "The Story of Neoprene," "Seamless-Tube Manufacture," and "Jimmy Lynch's Dare Devil Drivers."

A.S.M.E. Local Sections

Coming Meetings

Anthracite-Lehigh Valley. November 28. Elks Club, Berwick, Pa., at 8:15 p.m. Subject: "Army Tanks," by F. A. Stevenson. senior vice-president, American Car and Foundry Company.

Birmingham. November 27. Tutwiler Hotel, at 7:45 p.m. Subject: "America Has Just Begun," by Captain A. A. Nichoson, personnel director, The Texas Company, New York, N. Y.

Detroit. November 7. Detroit Leland Hotel at 8:00 p.m. Subject: "Heat and Mechanical Stresses in Welding," by W. G. Theisinger, director of welding research, Lukens Steel Co., Coatesville, Pa.

Metropolitan. November 14. Room 502, Engineering Societies Building, 29 West 39th St., New York, N. Y., at 7:30 p.m. Subject: "Recent Developments in Bridge Design—Failure of the Tacoma Narrows Bridge," by D. B. Steinman, consulting engineer, New York, N. Y.

New Haven. November 18. Mason Laboratory, Yale University, New Haven, Conn., at 8:00 p.m. Subject: "Metals and Cutting Tools for Increased Production," by Malcolm F. Judkins, chief metallurgist, Firth-Sterling Steel Co., and also chairman of the Special A.S.M.E. Research Committee on Cutting Metals.

Providence. November 4. R. I. State College, Kingston, R. I., at 8:00 p.m. This will be a joint Meeting of the Providence Section with the R. I. State and Brown University Student Branches. R. I. State Students are arranging the entire program. Providence members to meet with the students for dinner before the meeting.

Rochester. December 11. Sagamore Hotel, Rochester, N. Y., at 8:15 p.m. Subject: "Home Defense," by Maxwell C. Maxwell, assistant to the president, Yale & Towne Manufacturing Company, New York, N. Y.

St. Joseph Valley. November 18. O. E. Zahn will talk on "Lithography."

Worcester. November 12. Meeting will be addressed by Tell Berna of the National Machine Tool Builders Association, Cleveland, Ohio. The program is in charge of Lawrence Ball of Whitinsville, Mass.

JOHN A. LAWRENCE, TOASTMASTER, JUST SEATING HIMSELF, AT THE SPEAKERS' TABLE AT AWARDS LUNCHEON DURING EASTERN STUDENT MEETING IN BROOKLYN, N. Y., APRIL 21–22

With the Student Branches

1941-1942 Year Opened by Student Branches of The American Society of Mechanical Engineers

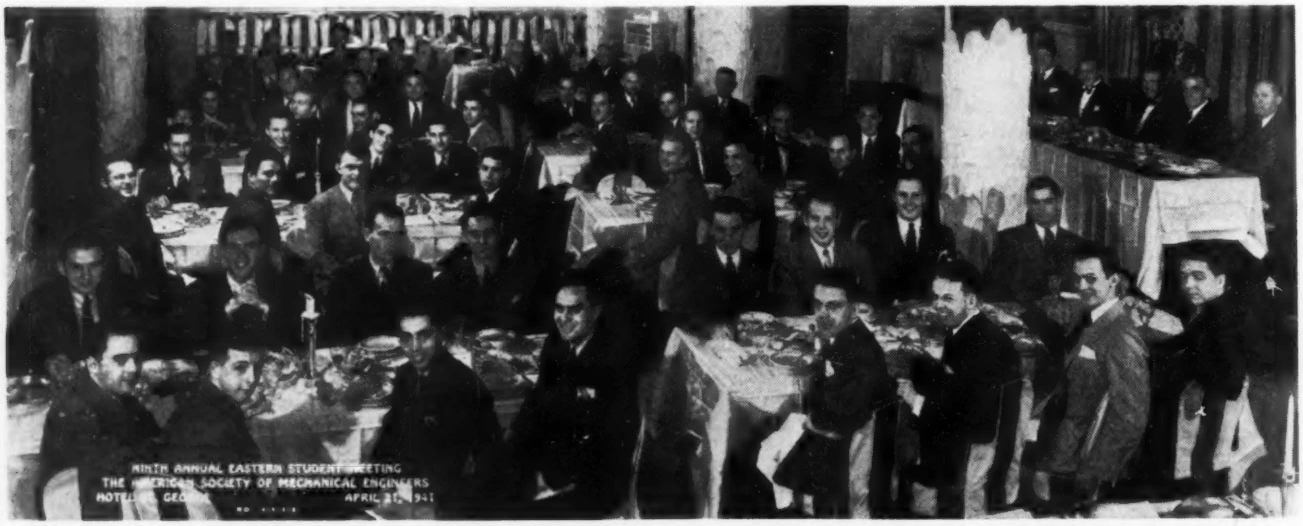
Arizona Welcomes New Members

ARIZONA BRANCH opened the new term with a meeting on Sept. 24 at which Chairman Horace B. West gave a description of the A.S.M.E., its objectives, activities, and aids to members. New members were made acquainted with the local organization, copies of MECHANICAL ENGINEERING were distributed and discussed, and dues were collected.

> The names of Student members will be included in the 1942 Membership List, in a special section, if their applications and dues are received at the headquarters of the Society by December 15, 1941.

Brooklyn Poly Plans Trips

Previous inspection trips in the fall have proved so successful at BROOKLYN POLY BRANCH that plans were formulated at the Sept. 30 meeting for the trips to continue this fall. A committee was selected by Chairman John G. Howard to arrange for the trips.



NINTH ANNUAL EASTERN STUDENT MEETING OF A.S.M.E., HOTEL ST. GEORGE, BROOKLYN, N. Y., APRIL 21, 1941

Football Rally at California

The first meeting of California Branch for the semester was held on Sept. 3. Following the introduction of officers and committee chairmen, further business was dispensed with so that the 100 old and new members could hear Walter Gordon, football coach, who spoke on "The Selection of a Winning Football Team."

Colorado State Professor Talks

At the initial meeting of the Colorado State Branch on Sept. 22 Chairman Marvin Schack explained to prospective members the advantages of membership in the organization. His talk was supplemented by Professor Strate who explained the future benefits of affiliating with the A.S.M.E. In accordance with custom, refreshments were served at the end of the meeting.

Delaware Hears About Propellers

The Oct. 2 meeting of Delaware Branch was opened by Chairman Alvin Green. After a brief business session, Mr. William Cole, Bellanca Aircraft Corp., spoke on the subject of propellers. After serving of refreshments, the meeting was adjourned.

Duke Holds Opening Rally

The first meeting of Duke Branch was an opening rally on Oct. 1 at which 56 members and prospective ones were present. After Chairman John Galt outlined the works of the A.S.M.E., student members gave short talks on heat-power engineering, manufacturing and production, and aeronautics. The rally was closed with the serving of refreshments in the mechanical-engineering laboratory.

Introductions at Florida

Florida Branch met on Sept. 19 for the first meeting of the term. All the student officers and Prof. R. A. Thompson, honorary chairman, were introduced. Committee members were then selected by Chairman J. H. Singer. Because of a conflict of the meeting time with their class schedules, the juniors tried without success to get future dates changed. However, on Sept. 30 after due consideration the meeting date was changed so that all could attend the affairs of the Branch.

WILLIAM HUNTER RECEIVES PRIZE OF $25 AT AWARDS LUNCHEON OF NINTH ANNUAL EASTERN STUDENT MEETING OF A.S.M.E.

Illinois Tech Gives Door Prizes

More than 100 students were present at the opening meeting of the Illinois Tech Branch on Oct. 3 and heard all about the advantages of membership from Professors Yellott, Winston, Nachman, and Roesch. After other business, a drawing for door prizes was held. The prizes consisted of a free membership in the Branch, a leather-covered notebook, and an automatic pencil.

Kentucky Meetings Crowded

The first two meetings of Kentucky Branch drew capacity crowds; 93 on Sept. 19 and 84 on Sept. 26. Both meetings were devoted to just plain business, including nomination and election of officers, distribution of Mechanical Engineering, and the collection of dues.

Missouri Mines Members Work

The members of Missouri Mines Branch did not spend an idle summer since most of them had jobs during the vacation period. Two of them described their work at the meeting of Sept. 23. Plans are already being made for the Branch's exhibit on Engineers' Day, Nov. 1.

Nebraska Chairman Gives Talk

After various items of business were discussed at the first meeting of Nebraska Branch on Sept. 24, Chairman Chester Lee started the ball rolling in the right direction by giving a paper on "The Design of Brass Castings and Patterns." Other members will follow suit at future meetings.

Membership Suggestions From Nevada

Among the various items of business discussed at the Sept. 10 meeting of the Nevada Branch were ways and means of stimulating interest in the organization and increasing its membership. Some of the suggestions advanced were having meetings announced in engineering classes, presentation of prizes for best papers by student members, and the establishment of a membership committee. Refreshments were served at the close of the meeting.

New Mexico Bull Session

After a brief business session, the New Mexico Branch meeting of Sept. 23 continued as a "bull session" over cider and doughnuts.

SEVENTH ANNUAL ROCKY MOUNTAIN STUDENTS' MEETING OF THE AMERICAN SOICETY OF MECHANICAL ENGINEERS AT DENVER, COL., APRIL 17–18, 1941

NINTH ANNUAL PACIFIC NORTHWEST STUDENTS' MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS AT SEATTLE, WASH., APRIL 28–30, 1941

Northeastern Student Shipbuilder

Student member James D. Brown was the speaker at the Sept. 18 session of the NORTHEASTERN BRANCH. Employed on a cooperative job by General Ship and Engine Works during the last shift into industry, he told how he designed and assisted in the construction of a tugboat, illustrating his talk with blueprints, copies of specifications, and pictures of the vessel under construction.

250 Attend Purdue Meeting

More than 250 students attended the initial meeting of PURDUE BRANCH on Sept. 18. After talks by Profs. H. L. Solberg and F. C. Hockema, copies of MECHANICAL ENGINEERING were passed out. Robert C. Morgan received the copy with the secretly mutilated page and thereby won a one-year membership as a prize. Following the showing of a "Fatty Arbuckle" movie of 1915, the boys indulged in cider, doughtnuts, and cigarettes. More than 100 members paid up their dues at this session.

Pittsburgh Is All Business

As reported by Secretary Walter Logan, the first meeting of PITTSBURGH BRANCH held on Sept. 25 was opened for business by Chairman Campbell Yates. About 120 students were present. After many of them had signed up as members, the meeting was adjourned.

Rice Lists Advantages for Joining

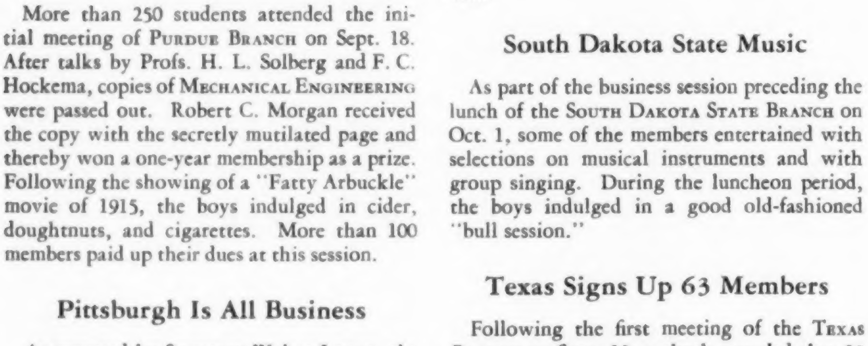
After the meeting of Sept. 24 was called to order by Chairman John F. Dillard of RICE BRANCH, Mr. Pound, honorary chairman, explained the benefits and advantages of the A.S.M.E. in connection with the social, technical, and curricular activities of the individual.

South Dakota State Music

As part of the business session preceding the lunch of the SOUTH DAKOTA STATE BRANCH on Oct. 1, some of the members entertained with selections on musical instruments and with group singing. During the luncheon period, the boys indulged in a good old-fashioned "bull session."

Texas Signs Up 63 Members

Following the first meeting of the TEXAS BRANCH on Sept. 29, a check revealed that 25 membership renewals and 38 new membership applications were recorded by the registration committee. Refreshments were served at the conclusion of the meeting.



AT THE SEPTEMBER 18 MEETING OF THE PURDUE BRANCH
(C. L. Brown takes photograph of group showing in front row, Professors F. C. Hockema, H. L. Solberg, A.S.M.E. Photographer, and Chairman Utley.)

Audience of 210 at Texas A.&M.

In order to give the boys time to settle down, the TEXAS A.&M. BRANCH meeting of Sept. 25 was opened with the showing of the motion picture, "Yellowstone National Park." After a brief talk by various officials about the advantages of membership, the 210 members and prospectives saw the film, "Science Rules the Rouge."

Texas Tech Organizes

The first meeting of TEXAS TECH BRANCH held on Sept. 24 was devoted to the organization of the Branch, election of officers, and the appointment of committee members.

Villanova Plans Activities

The Sept. 29 session of VILLANOVA BRANCH was a general affair devoted to discussion of a program for the coming year. It was the consensus of all that a program of activity is preferable and should be initiated and carried through by the members working as a group. Therefore, two of the Branch Members were selected to deliver papers at the next meeting on Oct. 3.

VPI Has 175 at Meeting

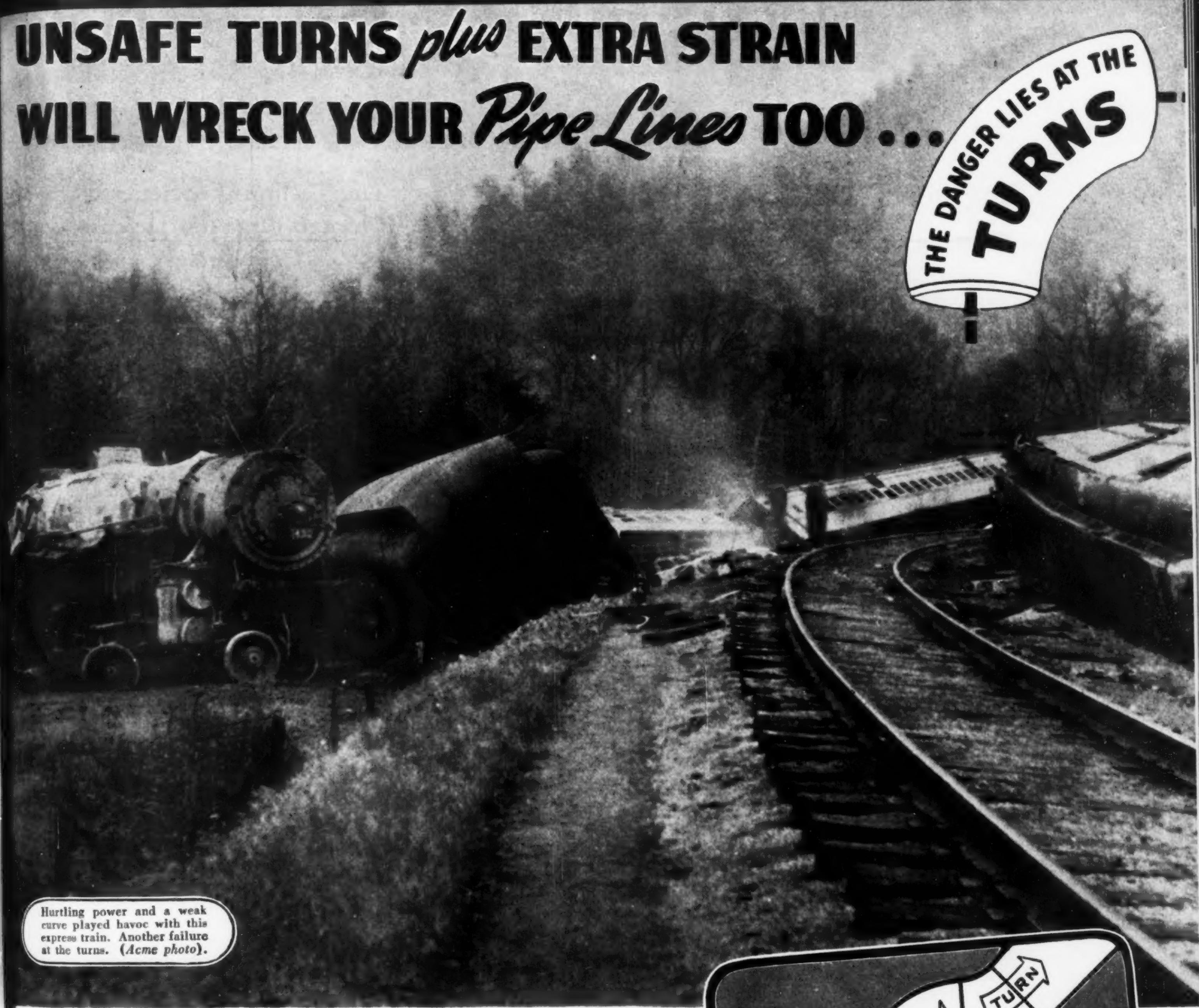
The first meeting of VIRGINIA POLYTECHNIC INSTITUTE BRANCH on Sept. 25 attracted an audience of 175, a record breaker. Besides papers by members at meetings, the Branch plans several inspection trips, the first one being to the Hercules Powder Plant at Radford, Va.

Yale Starts Off Year

On Sept. 23, YALE BRANCH got under way with an organization meeting which was addressed by Dean S. W. Dudley. He urged all students to join the A.S.M.E. and expressed the hope that membership would be 100 per cent.

(*A.S.M.E. News continued on page 840*)

UNSAFE TURNS *plus* EXTRA STRAIN WILL WRECK YOUR *Pipe Lines* TOO . . .



Hurtling power and a weak curve played havoc with this express train. Another failure at the turns. (*Acme photo*).

Weld your piping with TUBE-TURN fittings for stronger, safer, trouble-free, "turns"

Many railroad disasters happen AT A CURVE—because that's where strain and wear hit hardest.

Piping systems face the same hazards. Pressure, friction, stress, and erosion punish your lines worst *at the turns*—wherever there is a change in direction.

That's why it is sound engineering to insure the *utmost* safety and strength at these danger points with TUBE-TURN Welding Fittings.

Welding with Tube-Turns gives your plant the assurance and economy of piping systems with longer life, better performance, space-saving layouts and virtually no maintenance interruptions.

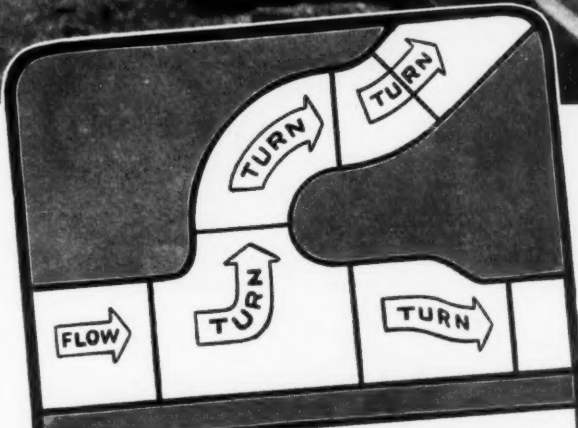
Write for helpful Tube-Turns engineering data book and catalog.

TUBE-TURNS, Inc., Louisville, Ky. *Branch offices:* New York, Philadelphia, Chicago, Pittsburgh, Cleveland, Tulsa, Los Angeles. Distributors everywhere.

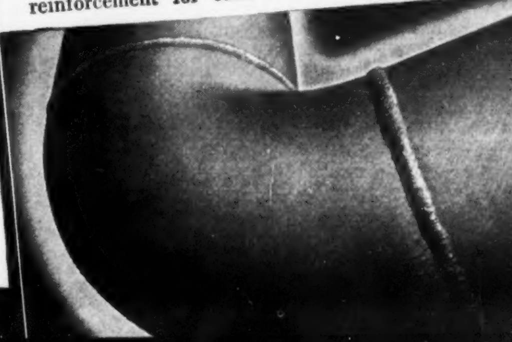
TUBE-TURN

TRADE MARK

Welding The FIRST WELDING FITTINGS 1ST AND STILL THE BEST *Fittings*



As indicated in the drawing above, there are vital "turns" in piping other than at elbows and returns. Tees, reducers, laterals, and nipples likewise entail abrupt changes in flow direction that result in *added* strain, friction and wear at these connections. The built-in strength of *all* Tube-Turn welding fittings gives unequalled reinforcement for *each* of these *danger spots.*



Engineers' Defense Board Organizes

New Working Organization of Engineers and Technologists

ESTABLISHMENT of the Engineers' Defense Board, a new working organization of engineers and technologists from the several national engineering societies to deal with technical problems on shortages, substitutions, conservation, raw materials, production, and reclamation in the nation-wide adjustment under the impact of the defense effort, was announced recently.

With an initial membership of five representatives each appointed by the governing bodies of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Society of Automotive Engineers, and the American Institute of Chemical Engineers, the new organization will assist the various branches of Government with engineering knowledge and experience on questions connected with military preparedness.

To Function as Clearing House

The Board will function as a clearing house for the engineering professions on information dealing with defense, particularly in relation to shortages, and through special committees will attempt improvements of standards and practices of long standing where savings of materials can be made. In many instances it is expected that the results will produce lasting benefit to the public as well as an immediate aid to defense. The Board also will take an interest in methods for implementing the work of the advisory technical committees of the National Academy of Science and will undertake specific studies on request of the Army, Navy, and official defense agencies.

Representatives Appointed

The representatives appointed by the governing bodies of the six engineering societies are:

American Society of Civil Engineers: Carlton S. Proctor, consulting engineer, executive committee representative; Richard E. Dougherty, vice-president, Improvements and Developments, New York Central System; Charles F. Goodrich, chief engineer, American Bridge Co.; Robert R. McMath, chairman of the board, Motors Metal Manufacturing Co.; J. P. H. Perry, vice-president, Turner Construction Co.

American Institute of Mining and Metallurgical Engineers: John F. Thompson, executive vice-president, International Nickel Co., executive committee representative; Zay Jeffries, technical director, Lamp Department, General Electric Co.; Wilber Judson, vice-president, Texas Gulf Sulphur Co.; Frederick Laist, metallurgical manager, Anaconda Copper Mining Co.; Wilfred Sykes, president, Inland Steel Co.

The American Society of Mechanical Engineers: R. M. Gates, president, Air Preheater Co., executive committee representative; H. V. Coes, industrial department, Ford, Bacon and Davis, Inc.; K. H. Condit, dean of engineering, Princeton University; J. W. Parker, vice-president and chief engineer, The Detroit Edison Co.; W. R. Webster, chairman of the board, Bridgeport Brass Co.

American Institute of Electrical Engineers: H. H. Barnes, Jr., General Electric Co., executive committee representative; C. A. Adams, Edw. G. Budd Mfg. Co.; C. B. Jolliffe, Radio Corporation of America; R. L. Jones, Bell Telephone Laboratories; Philip Sporn, vice-president in charge of engineering, American Gas and Electric Service Corporation.

Society of Automotive Engineers: C. L. McCuen, vice-president and chief engineer, General Motors Corporation, executive committee representative; Rex B. Beisel, chief engineer, Vought-Sikorsky Aircraft Corporation; C. E. Frudden, Allis-Chalmers Mfg. Co.; Arthur Nutt, vice-president, Wright Aeronautical Corporation; James C. Zeder, chief engineer, Chrysler Corporation.

American Institute of Chemical Engineers: F. W. Willard, president, Nassau Smelting & Refining Co., executive committee representative; Webster Jones, Carnegie Institute of Technology; R. L. Murray, vice-president, Hooker Electrochemical Co.; A. J. Weith, manager of research, Bakelite Corporation; R. E. Wilson, president, Pan-American Petroleum and Transport Co.

Serving as officers of the Engineers' Defense Board are Robert E. McConnell, OPM consultant, chairman; Harry S. Rogers, president of Polytechnic Institute of Brooklyn, vice-chairman; and A. B. Parsons, secretary of the American Institute of Mining and Metallurgical Engineers, secretary.

1942 Officers of A.S.M.E. Elected by Letter Ballot

AS reported by the tellers of election, William H. Boehm, William N. Dickinson, and Elmer H. Neff, letter ballots received from A.S.M.E. members were counted on Tuesday, September 23. The total number of ballots cast was 4108 but of these 145 were thrown out as defective.

The final results as tabulated:

Candidates	*Votes for*	*Votes against*
President:		
JAMES W. PARKER	3958	5
Vice-Presidents:		
CLARKE F. FREEMAN	3949	14
CLAIR B. PECK	3950	13
WILLIAM H. WINTERROWD	3957	6
WILLIS R. WOOLRICH	3954	9
Managers:		
WILLIAM G. CHRISTY	3956	7
HERBERT L. EGGLESTON	3960	3
THOMAS S. MCEWAN	3955	8

The new officers will be introduced and installed in office during the Sixty-Second Annual Meeting of the Society to be held in New York, N. Y., December 1–5, 1941.

The Technical Societies of Chicago Organize Defense Committees

ACCORDING to the Bulletin of the Western Society of Engineers, a number of professional and technical societies, including the Chicago Section A.S.M.E., have organized National Defense Committees to promote a program of National Defense, particularly appropriate for the technical men of the Chicago area.

This associated group has the following objectives in view:

1 To stimulate thought among persons of high technical training on matters pertaining to National Defense.

2 To provide a small forum for the discussion of new ideas related to National Defense, and to provide technical assistance for the development and expansion of embryonic ideas.

3 To provide a channel for the speedy communication of worth-while ideas to the appropriate governmental agencies.

4 To cooperate with similar groups in other technical societies in exchanging information and correlating the work of such groups.

Juan T. Trippe Awarded Daniel Guggenheim Medal

ANNOUNCEMENT has been made of the award of the 1941 Daniel Guggenheim Medal to Juan T. Trippe, president of Pan-American Airways, for "the development and successful operation of oceanic air transport." The medal will be conferred next January at a dinner of the Institute of the Aeronautical Sciences.

Mr. Trippe, who was an ensign in the Naval Air Service during the World War, was graduated from Yale University in 1920 and shortly thereafter helped to organize Colonial Airways, America's first commercial air line. In 1926 he withdrew as general manager and organized Pan-American Airways, a system which now operates 78,000 miles of air routes, the largest air network under one flag, connecting the United States with 55 nations and colonies.

The Daniel Guggenheim Medal Board of Award, whose headquarters are at 29 West 39th Street, New York, N. Y., is made up of three representatives each of the Society of Automotive Engineers, The American Society of Mechanical Engineers, and the Institute of the Aeronautical Sciences; a representative of the United Engineering Trustees, Inc., which acts as treasurer; eight life members who are the former recipients of the Medal; and five foreign members. James H. Doolittle is chairman of the board, Jerome C. Hunsaker, member A.S.M.E., is vice-chairman, and Charles H. Colvin is secretary. Representatives of The American Society of Mechanical Engineers who will serve as members for the board for the fiscal year October, 1941, to September, 1942, are Alexander Klemin, R. F. Gagg, and E. E. Aldrin.

(*A.S.M.E. News continued on page 842*)

"GOOD VALVE PRACTICE"

For a Meat Packing Plant

(STEAM, WATER AND PROCESS CONNECTIONS)

Jenkins SUGGESTS . . .

utlook in the meat packing field points a still further increase in production cilities, improvements in arrangement departments and the use of mass-oduction techniques. Although actual stallations vary widely in size and mplexity of steam, water or process ping requirements, valves must be in-alled in accordance with accepted good lve practice. In addition, each control point must have a valve designed and constructed to serve efficiently and economically in that specific service. For the diagram below, each control point is keyed to the reference chart where the *basic* valve types are recommended. Then, by offering several Jenkins Figure Numbers, the *specific* valve can be selected by a study of your own requirements.

**REFERENCE CHART
FOR JENKINS FIGURE NUMBERS**

	Standard	Medium	Extra Heavy
A STEAM LINES GATE	BRONZE 47 Sc. Travel Spindle 49 Sc. Travel Spindle 370 Sc. Non-Rising 368 Sc. O.S. & Y. 670 Sc. Non-Rising 672 Sc. O.S. & Y. IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S. & Y. 651 Fl. O.S. & Y.	BRONZE 270 Sc. Non-Rising 275 Sc. O.S. & Y. IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	BRONZE 280 Sc. Non-Rising 282 Sc. O.S. & Y. IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y.
SWING CHECK	BRONZE 92 Sc. Regrinding 352 Sc. Disc Type 762 Sc. Regrinding IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	BRONZE 762 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type	BRONZE 962 Sc. Regrinding 260 Sc. Disc Type IRON 338 Sc. Disc Type 339 Fl. Disc Type
GLOBE	BRONZE 106A Sc. Disc Type IRON 612 Sc. Regrinding 613 Fl. Regrinding 141 Sc. Disc Type 142 Fl. Disc Type	BRONZE 750 Sc. Regrinding 950 Sc. Regr.-Renew 956 Sc. Regr.-Renew Plug IRON 918 Sc. Regrinding 919 Fl. Regrinding 774 Sc. Disc Type 775 Fl. Disc Type	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Renew 970 Sc. Regr.-Renew 976 Sc. Regr.-Renew Plug IRON 922 Sc. Regrinding 923 Fl. Regrinding 162A Sc. Disc Type 162 Fl. Disc Type
B WATER LINES GATE	BRONZE 47 Sc. Travel Spindle 49 Sc. Travel Spindle 370 Sc. Non-Rising 368 Sc. O.S. & Y. 670 Sc. Non-Rising 672 Sc. O.S. & Y. 674A Sc. Non-Rising 675A Fl. Non-Rising 676A Sc. O.S. & Y. 677A Fl. O.S. & Y. IRON Same as "A" above	BRONZE 270 Sc. Non-Rising 275 Sc. O.S. & Y. IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	BRONZE 280 Sc. Non-Rising 282 Sc. O.S. & Y. IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y.
SWING CHECK	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above	BRONZE & IRON Same as "A" above
QUICK OPENING	BRONZE 712 Sc. Disc Type 720 Sc. Disc Type 941 Sc. Disc Type 376 Sc. Sliding Spindle IRON 334 Sc. Sliding Spindle 335 Fl. Sliding Spindle		
C GAS SUPPLY GLOBE	106A Sc. Disc Type 169G Sc. Disc Type Lock Shield		
GATE	47 Sc. Travel Spindle 370 Sc. Non-Rising 318 Sc. Non-Rising Lock Shield		
SWING CHECK	92 Sc. Regrinding 352 Sc. Disc Type		
D COMPRESSED AIR LINES GLOBE	106A Sc. Disc Type 169 Sc. Lock Shield		
GATE	47 Sc. Travel Spindle 370 Sc. Non-Rising 318 Sc. Lock Shield		
E SOLUTION LINES HAND GUN	609 Sc. Button Type 610 Sc. Lever Type 121 Sc. Lever Type		
GLOBE	106A Sc. Disc Type 750 Sc. Regrinding		

JENKINS BROS., 80 White St., New York, N.Y.; Bridgepor Conn.; Atlanta, Ga ; Boston, Mass.; Philadelphia, Pa.; Chicag Ill.; Houston, Texas. Jenkins Bros., Ltd., Montreal; London, Eng

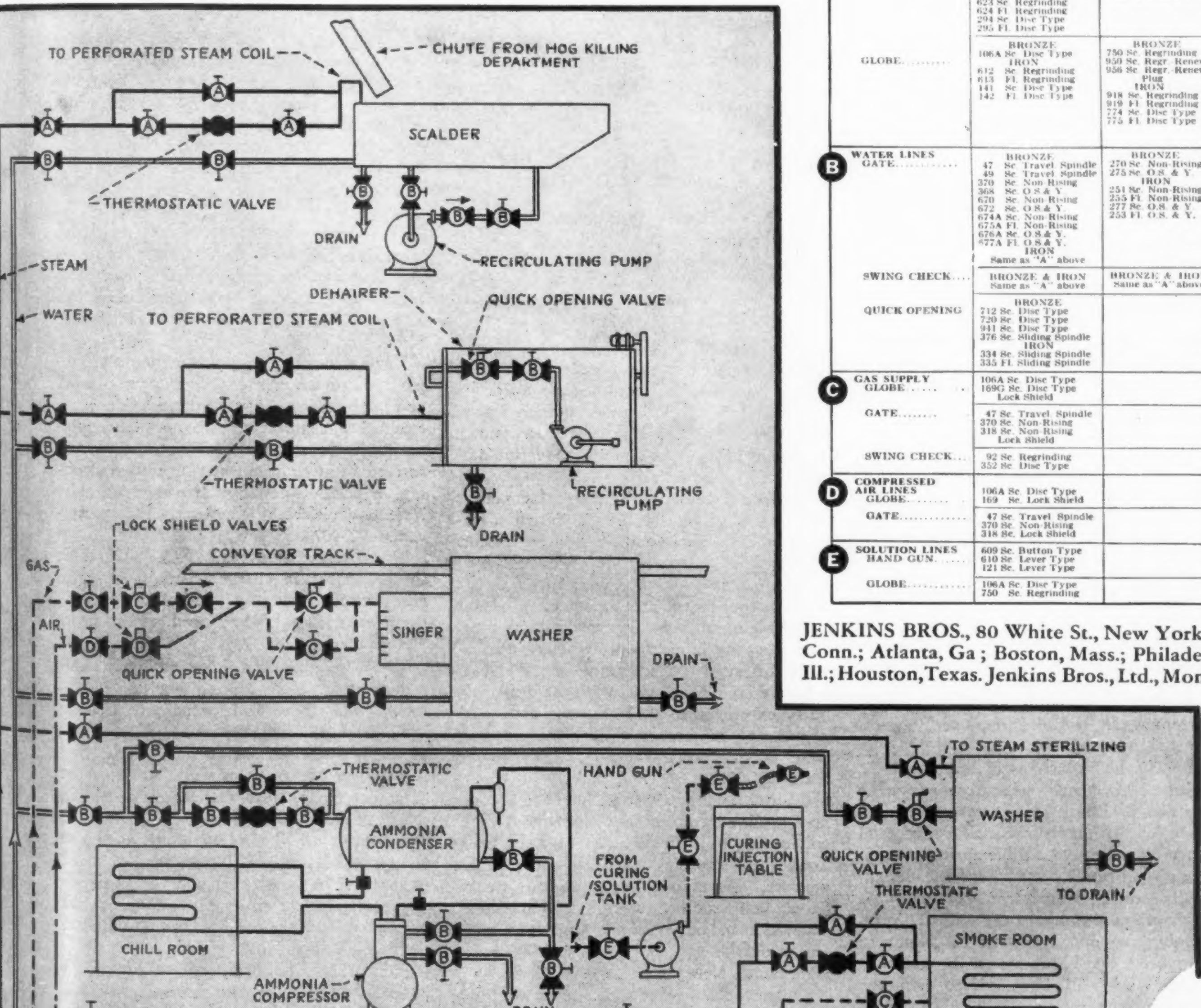


Diagram courtesy of Huxley Madeheim, Consulting Engineer

#8 OF A SERIES designed to help in your selection of JENKINS VALVES

IN VALVES Jenkins GIVES YOU EVERYTHING

Men and Positions Available

Send Inquiries to New York Office of Engineering Societies Personnel Service, Inc. This service is operated on a cooperative, nonprofit basis whereby those actually placed in positions by the Service agree to contribute to help maintain this service

29 W. 39th St. New York, N. Y. | **211 West Wacker Drive Chicago, Ill.** | **57 Post Street San Francisco, Calif.** | **Hotel Statler Detroit, Mich.**

MEN AVAILABLE[1]

MECHANICAL ENGINEER, 26, single. Five years' drafting, calculating and designing experience in Diesel engines, steam turbines, and mining machinery. Good knowledge of mathematics, stress analysis, thermodynamics. Speaks fluent Russian and German. Prefers location in U. S. A. Me-696.

PUMP ENGINEER, 29; B.S. in mechanical engineering. Experienced in research and development of rotary pumps, high vacuum, fuel oil, lubricating oil. Me-697.

MECHANICAL ENGINEER with 11 years' experience in production, assembly, and testing machinery, woodworking, chemical and textiles processes and equipment, and familiar with supplies of many types of equipment; wide sales experience; desires purchasing position with responsibilities. Prefers Middle-Western location. Me-698.

MECHANICAL ENGINEER, 24; B.S. degree, 1940, Penn State. Desires position requiring initiative and responsibility doing research, testing, or design in field pertinent to mechanical engineering. Now employed. No location preference. Me-699.

MECHANICAL ENGINEER, 38. Sixteen years' experience in district steam service, central-station power, and utility construction. At present well employed, but interested in above-average permanent executive position. Me-700.

PLANT SUPERINTENDENT, available immediately. Now employed as mechanical superintendent of large ordnance plant in Middle West; direct supervision of 1300 men; long training in all phases of manufacture of machinery, ordnance, etc. Me-701.

MECHANICAL-INDUSTRIAL ENGINEER, 48, technically educated, American, broad diversified experience, excellent record of accomplishments. In present position as chief engineer of large industrial organization, over 9 years. Desires change. Me-702.

MECHANICAL DEVELOPMENT ENGINEER, 33, married. M.E. degree; presently employed in responsible position. Many creative contributions include nationally marketed products and patents; possesses compatible aptitudes engineering practicability, and aesthetic design; tactfully forceful, cooperative. Me-703.

MECHANICAL ENGINEER, 48, with 27 years of engineering and executive experience in steel, process, and heavy industries, primarily on plant work; fully qualified to discharge engineering or executive duties. New York license. Me-704.

MECHANICAL ENGINEER, M.I.T. graduate, 27, limited experience. Desires permanent position with large or medium-size manufacturer for development work in industry where thorough knowledge of thermodynamics, combustion problems, heat transfer, and machine designing is essential. Me-705.

MECHANICAL ENGINEER, 28; married. Two and one-half years' professional experience in production, cost, maintenance, and machine-shop supervision. Two years' stenographic experience. Interested in management or development work. Permanent only. Me-706.

MECHANICAL ENGINEER, 31, single. Foreman of instrument-repair department in large petroleum refinery. Experienced in selection and application of new instruments as well as instrument repair. Me-707.

[1] All men listed hold some form of A.S.M.E. membership.

POSITIONS AVAILABLE

GRADUATE ENGINEERS, 25-35, preferably with experience on commercial side; not design. Should have general technical ability. Also need men well informed on machine tools. Must be British or American citizens. Salary, \$2500-\$4000 year. Headquarters, New York, N. Y. Y-8974.

MECHANICAL ENGINEER at least 38, with good background in machine-shop operation to act as liaison man between engineering and production departments in effort to eliminate mechanical snags and step up production output. New England. Y-8983.

DESIGNERS, graduate mechanical engineers with considerable experience in design of machine tools or similar mechanical equipment. Connecticut. Salary, to \$5200 year. Y-8989.

GENERAL SUPERINTENDENT, not over 50, for machine-tool manufacturing company. Must have at least ten years' experience in machine-tool company in executive capacity. Permanent. Salary, over \$7500 year. East. Y-9002.

INDUSTRIAL ENGINEER with at least ten years' experience in production and industrial engineering in machine-shop plant. Permanent. Salary, \$6000-\$7500 year. New York State. Y-9019.

PLANT MANAGER about 40, mechanical engineer preferred who is fully acquainted with cold-rolling mill production. Must be wide awake and capable of withstanding high-pressure, fast-moving organization work. Should know tooling, be resourceful in getting material in and out of shop. Must know modern production methods; salary, \$6000 year. Permanent. New Jersey. Y-9023.

ASSISTANT PLANT ENGINEER, about 40, who is fully acquainted with design, development, and maintenance of heavy machinery for cold-rolling of steel and nonferrous metals. Salary, \$4000-\$5000 year. Permanent. New Jersey. Y-9024.

PLANT MANAGER. Graduate mechanical engineer preferred to act as manager of small fast-growing Midwestern plant manufacturing product greatly in need due to shortage of metals. Knowledge of chemical plants would be beneficial but thorough knowledge of and ability to handle human traits is essential. Engineer with New England experience preferred. Permanent. Salary open. Y-9025.

PLANT SUPERINTENDENT for small manufacturing plant. Must know tool-and-die design and set up, be able to schedule production, and complete the assembly of work. Small-parts manufacturing. Salary open. New York metropolitan area. Y-9034 (a).

PRODUCTION ENGINEERS experienced in manufacture of radio or telephone equipment, precision instruments, office machinery, and automatic equipment for government work, as expediters. Salaries, from \$3200-\$5600 year. Headquarters, Chicago, New York. Y-9038.

MECHANICAL ENGINEER, about 40, to head up engineering department for armament-manufacturing company. Must know tool, jig, and fixture layout and design and have general machine-shop background. Salary, to \$6000 year. Eastern Pennsylvania. Y-9045.

MACHINE SHOP SUPERINTENDENT who has supervised shop doing high-precision work. Must be able to keep product moving and supervise plant-production clerks. Permanent. Salary, \$5000-\$6000 year. New Jersey. Y-9049.

GRADUATE MECHANICAL ENGINEER with previous experience in metal manufacturing, as production engineer, plant superintendent, or similar duties. Must be good administrator. Salary, \$4000-\$5000 year. Defense work. New York, N. Y. Y-9057.

DEVELOPMENT ENGINEERS for long-time employment on development of variety of old and new products in organized department of large established manufacturer of power-plant equipment. High academic standing required; experience in either manufacturing, design, drafting, or previous development work desirable. American citizenship imperative. Pennsylvania. Y-9073.

MECHANICAL ENGINEER, 35-45, as assistant superintendent in charge of tools for large manufacturing company. Must have pressed-metal experience. Salary open. Permanent. New England. Y-9077.

SHOP MANAGER AND SUPERVISOR for small manufacturing plant making precision instruments. Must have background of experience in tools, jigs, fixtures. Salary, \$6000-\$8000 year. New York, N. Y. Y-9083.

ASSISTANT MASTER MECHANIC, 30-35; must be graduate mechanical engineer. Will be in charge of all plant construction, erection, and replacement. Will also have charge of the plant machine shop. Will be required to make estimate for proposed work and will supervise design of all plant structural and mechanical alterations. Permanent. Salary, \$3600 year. New Jersey. Y-9107.

MECHANICAL ENGINEER, under 40, interested in teaching courses in shop processes, machine design, elementary engineering materials. Should have some knowledge of process machinery, i.e., knitting or paper-making machines, printing presses, or the kinematics of mechanisms as brought out in these types of

(*A.S.M.E. News continued on page 844*)

In big hoists enormous loads are applied frequently and suddenly to the heavy-sectioned drum shafts.

One manufacturer of such equipment makes his shafts of Chromium-Molybdenum (SAE 4140) steel. Even in the 4 to 9 inch sections used, the steel develops the requisite fatigue strength and toughness. And, since it machines well at the specified hardness (250 B.H.N. min.), the shafts can be bought in the heat treated condition and simply finished in the user's shop — an important economy.

Write for our free technical book, "Molybdenum in Steel".

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED · FERROMOLYBDENUM · CALCIUM MOLYBDATE

MOLY

Climax Mo-lyb-den-um Company
500 Fifth Avenue · New York City

machinery. Salary open. New York, N. Y. Y-9110.

MECHANICAL ENGINEER, 35–40, for installation of heavy refrigeration equipment. Must have some experience in field handling mechanics. Some traveling. Permanent. Salary, $3600–$4200 a year. New York, N. Y. Y-9117.

INDUSTRIAL ENGINEER, 42–47, with diversified experience in production field. Must be able to carry out time and motion study, job specification, and production-planning program. Should have good mechanical background and be able to do machinery purchasing. Must know refrigeration and packaging machinery. Permanent. Salary, to $5200 a year. New Jersey. Y-9118.

WORKS MANAGER, 40–50, for machine-tool manufacturer. Will be in entire charge of plant responsible only to president. Salary open. Location, New England. Y-9142.

CHIEF ESTIMATOR for machine-tool company. Should have shop viewpoint as he will be in charge of standards, rate setting, control of waste, inspection, and supervision of design of jigs, tools, and fixtures. Salary, $5000 year. New England. Y-9144.

MECHANICAL ENGINEERS. (*a*) For supervisors and foremen positions, should be experienced in industrial-plant and powerhouse maintenance work. M.E. degree and 5 years' plant experience preferred. Work on new plants on government defense work. (*b*) Junior mechanical engineer with potentiality for foreman-training group. If interested write for company application blanks. Salaries, $3000–$4800 year. South and Middle West. Y-9145.

ESTIMATOR, mechanical, with experience in fabrication of airplane parts, i.e., blanking, riveting, welding. Permanent. Salary, $3900–$5200 year. Connecticut. Y-9157.

MECHANICAL ENGINEER, designer and draftsman, to take charge of drafting room, especially in regard to machine tools and automaticmachine design. Salary, $4800 year. Washington, D. C. Y-9160.

TECHNICAL EDITOR, graduate mechanical engineer, with some writing experience as well as production experience in metal-working industries. Salary, to $5000 a year. New York, N. Y. Y-9165.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after November 25, 1941, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member

NEW APPLICATIONS

For Member, Associate, or Junior

ADAMS, PAUL, Dedham, Mass. (Rt)
BOCK, EDWARD J., Anniston, Ala.
BRODERICK, E. L., New Haven, Conn.
CANNON, JOHN B., JR., Rockaway, N. J.
CARREAU, HENRY C., Norwood, Pa.
CLEMENT, GEO. H., Santa Monica, Calif.
CONSTANCE, JOHN D., North Bergen, N. J.
DAVIDSON, JOHN L., Scarsdale, N. Y. (Rt)
DE CAMP, RAY E., Glendale, Calif.
DEUTSCH, J. T., Ithan, Pa.
EDLEFSEN, ROBT. P., Marysville, Calif.
ENGLISH, EDWIN H., Waterbury, Conn.
FAUS, HERBERT W., New York, N. Y.
GADD, CHAS. W., Detroit, Mich.
GRADY, E. GLENNAN, Laurel, Miss.
GUTSCH, OSCAR H., El Paso, Texas
HAINSWORTH, BRUCE A., Cleveland, Ohio
HAMMERSLEY, RALPH, Waterford, N. Y. (Rt)
HARRER, THEO. M., Oakland, Calif.
HILDERBRAND, EWING A., Dallas, Texas
IRWIN, JOHN S., Yonkers, N. Y.
JAMESON, ALBERT S., New York, N. Y.
KELLER, ALLEN, West Lynn, Mass.
KELLER, JOHN D., Pittsburgh, Pa.
KROLL, JOSEPH, Watts Bar Dam, Tenn.
LANDIS, WARREN C., New York, N. Y.
LEPLEY, RAYMOND D., Philadelphia, Pa.
LINKLETTER, RICHARD L., Seattle, Wash.
LUCEY, P. J., Des Plaines, Ill.
LUKENS, ARCH M., Mexico D.F., Mex.
MAJNERI, LUDWIG A., Detroit, Mich.
MANKE, GUSTAVE L., Hartford, Conn.
MCNEILE, GEO. R., South Bend, Ind.
MEISTER, ABRAM, Yonkers, N. Y. (Rt & T)
MITCHELL, WM. J., Brooklyn, N. Y.
MOE, CLARENCE M., Little Rock, Ark.
MOHLER, VALENTINE, River Forest, Ill. (Rt)
MUENGER, JAS. R., Beacon, N. Y.
NYGREN, JOHN, Staten Island, N. Y.
PARSONS, HAROLD K., Cincinnati, Ohio (Rt)
PHILLIPS, ARTHUR L., Montreal, Que., Can.
PLUNKETT, ROBT., Cambridge, Mass.
PUDER, ROLAND W., Bergenfield, N. J.
RAMSTEDT, AXEL J., Osburn, Idaho
REINTJES, GEO. P., Kansas City, Mo.
RIANHARD, THOS. M., JR., Middlebury, Conn.
SEARLES, WM. L., Plainfield, N. J.
SIMONS, EUGENE M., Blacksburg, Va.
SOBEL, CHAS., New York, N. Y.
SPAHR, JOHN C., Springfield, Pa.
UHLER, W. P., Tottenville, S. I., N. Y.
WALL, ALBERT G., St. Louis, Mo.
WAIT, WILLIAM B., New York, N. Y.
WALTER, HAROLD E., Newark, N. J.
WATSON, SAML. R., Croton-on-Hudson, N. Y. (Rt & T)
WELSH, WM. H., Brooklyn, N. Y.
WEST, JOHN T., Allentown, Pa.
WIRTANEN, CHAS. W., New York, N. Y.
ZADRA, HARRY S., Columbus, Ohio

(*Continued in next column*)

CHANGE OF GRADING

Transfers to Fellow

TOLMAN, CHAS. P., Kew Gardens, L. I., N. Y.
SMITH, ARTHUR R., Schenectady, N. Y.

Transfers to Member

BAILEY, CHAS. A., Gary, Ind.
BELTRAN, EDW. V., New York, N. Y.
FALLS, EUGENE K., Potsdam, N. Y.
FORSYTHE, PAUL E., Mercer Island, Wash.
FRANCK, CLARENCE C., Swarthmore, Pa.
HABER, HAROLD E., JR., New York, N. Y.
HENWOOD, JAS. B., Bala-Cynwyd, Pa.
LEE, EDW. R., JR., Glen Rock, N. J.
LINK, CHAS. T., JR., Chicago, Ill.
PALM, BERNHARD N., San Marino, Calif.
SCHULTZ, ALFRED W., Chicago, Ill.
SULLENDER, WM., La Marque, Texas

A.S.M.E. Transactions for October, 1941

THE October, 1941, issue of the Transactions of the A.S.M.E. contains:

Heat Transfer to Hydrogen-Nitrogen Mixtures Inside Tubes, by A. P. Colburn and C. A. Coghlan
Electric-Slip Couplings for Use With Diesel Engines, by A. D. Andriola
Flexible Couplings for Internal-Combustion Engines, by J. Ormondroyd
Combustion Explosions in Pressure Vessels Protected With Rupture Disks, by M. D. Creech
Mathematics of Surge Vessels and Automatic Averaging Control, by C. E. Mason and G. A. Philbrick
Graphical Methods for Plotting Time-Speed-Distance Curves for Railway Trains, by A. I. Lipetz
Power Losses in High-Speed Journal Bearings, by F. C. Linn and D. E. Irons
Flow Properties of Lubricants Under High Pressure, by A. E. Norton, M. J. Knott, and J. R. Muenger
A New Degasifying Steam Condenser for Use in Conductivity Determinations, by F. G. Straub and E. E. Nelson
A High-Temperature Bolting Material, by A. W. Wheeler

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

CHANDLER, CLARENCE A., September 6, 1941
CUMMINGS, S. R., February, 1941
EIDMANN, FRANK L., September 4, 1941
EMMET, WILLIAM LEROY, September 26, 1941
MARBURG, LOUIS H., July 25, 1941
MORRISON, LACEY H., September 20, 1941
SMITH, EDWARD J., August 16, 1941
SMITH, ROBERT M., June 12, 1941
TERZIAN, H. G., September 2, 1941
WILFORD, JAMES W., September 7, 1941
WILLIS, EDWARD J., July 11, 1941

Engineering Societies Building, 29 West 39th St., New York, N.Y., Headquarters of the A.S.M.E.

Program

SIXTY-SECOND

A.S.M.E. Annual Meeting

HOTEL ASTOR · · · NEW YORK, N. Y.
(Times Square, Broadway — 44th to 45th Street)

December 1 to 5, 1941

• **Hotel Astor, *located on Times Square*, where all functions of the 1941 Annual Meeting are being held**

CATALOG BRIEFS

A List of Latest Industrial Literature

On page 32 of this Section begins a Comprehensive List of Catalogs, Bulletins, Handbooks, Data Books, Charts and other engineering information made available by current advertisers in MECHANICAL ENGINEERING and the A.S.M.E. MECHANICAL CATALOG.

Program of A.S.M.E. Sixty-Second Annual Meeting

New York, N. Y., December 1–5, 1941

Headquarters, Hotel Astor

MONDAY, DECEMBER 1

9:30 a.m.

Council Meeting
Sections Delegates' Meeting

2:00 p.m.

Business Meeting

3:30 p.m.

Professional Divisions' Conference
Sections Delegates' Meeting
Council Meeting

8:00 p.m.

Vibration

Investigation of Self-Excited Torsional Oscillations and Vibration Damper for Induction-Motor Drives, by A. M. Wahl and E. G. Fisher[1]
Graphical Analysis of Impact of Elastic Bars, by K. J. DeJuhasz[1]
Harmonic Coefficients of Engine Torque Curves, by F. P. Porter
Some Dynamic Properties of Rubber, by C. O. Harris[1]

Power

Engineering Problems in Water-Steam Cycle of Central Steam Generating and Decentralized Control Systems, Parkchester, Bronx, N. Y., by S. T. Powell and John A. Dondero

Work Standardization

Better Wage Indices for Metal-Working Plants, by C. Canby Balderston[1]
Index of Wage Rates as a Factual Basis for Wage Determination, by L. Clayton Hill
Index of Wage Rates as a Factual Aid in Collective Bargaining, by Harold J. Ruttenberg
Discussers:
John R. Steelman, A. F. Hinrichs, and Robert A. Sayre

Fuels

Trends in Design of Pulverized-Coal Burners, by Henry Kreisinger and V. Z. Caracristi
Combustion of Pulverized Fuel—Mechanism and Rate of Combustion of Low-Density Fractions of Certain Bituminous Coals, by A. A. Orning[1]

TUESDAY, DECEMBER 2

9:30 a.m.

Sections Delegates' Conference

Machine Design

Modern Elevator Practice, by E. M. Bouton[1]
What Is Wrong With Kinematics and Mechanisms, by A. E. R. deJonge[1]

[1] To be preprinted for 1941 Annual Meeting.

TUESDAY (*continued*)

9:30 a.m.

Analysis of Thin-Walled Structures

Torsion of Multiconnected Thin-Walled Cylinders, by F. M. Baron[1]
Torsional and Flexural Buckling of Bars of Thin-Walled Open Section Under Compressive and Bending Loads, by J. N. Goodier[1]
On the Distribution of Stress in Built-In Beams of Narrow Rectangular Cross Section, by F. B. Hildebrand and Eric Reissner[1]
Buckling of Semimonocoque Structures Under Compression, by Tsun Kuei Wang[1] (by title)
Note on Plane Strain, by Wm. R. Osgood[1] (by title)

Mathematical Statistics

The Essentials of Control-Chart Analysis, by Edwin G. Olds
An Application of Sampling Inspection Based on the Variables Method, by C. S. Barrett

Metals Engineering

The Physical Properties of Cartridge Brass, by Royden S. Pratt
The Foren Mill a Seamless-Tube Rolling Unit Closely Approaching the Continuous-Production Method, by E. W. Wrage[1]

Industrial Instruments

Analyses of a Continuous Process by a Discontinuous Step Method, by John A. Hrones
Optimum Settings for Automatic-Controllers, by J. G. Ziegler and N. B. Nichols[1]

12:30 p.m.

National Defense Luncheon

2:00 p.m.

Power-Hydraulic (I)

Hydraulic Engineering Problems at Philadelphia Electric Company's Southwark Station, by S. Logan Kerr and Stanley Moyer
Original Features Embodied in New 160,000-Kw Oswego Steam Station, by N. R. Gibson and H. M. Cushing[1]

Boiler Feedwater Studies (I)

Symposium on Caustic Embrittlement:
Results of Laboratory Embrittlement Testing of Boiler Waters, by F. G. Straub[1]
Embrittlement of Boiler Steel—Experiences With the Schroeder Detector, by T. E. Purcell and S. F. Whirl[1]
Experience With Intercrystalline Cracking on Railroads, by R. C. Bardwell and H. M. Laudemann[1]

TUESDAY (*continued*)

2:00 p.m.

Mechanical Properties of Materials

The Technical Cohesive Strength of Metals, by D. J. McAdam, Jr.[1]
Correlation of Residual Stresses in the Fatigue Strength of Axles, by O. J. Horger
A Short-Gage-Length Extensometer, and Its Application to the Study of Crankshaft Stresses, by Charles W. Gadd and Thos. C. Van Degrift[1]
A New Lateral Extensometer, by A. V. deForest and A. R. Anderson[1]

Machine Shop Practice

Transfer Machines at Cincinnati Plant of Wright Aeronautical Co.

Lubrication

Characteristics of Centrally Supported Journal Bearings, by E. O. Waters[1]
Symposium on Thermal Conditions in Bearings:
Heat Conditions in Bearings—An Outline of Problems for Research, by M. D. Hersey
Effect of Diametral Clearance on the Load Capacity of a Journal Bearing, by J. T. Burwell
Notes on Heat Dissipation in Self-Contained Bearings, by G. B. Karelitz

Heat Transfer

Radiation Configuration Factors Using Light in Furnace Models, by Fred England and Huber O. Croft[1]
High-Performance Fins for Heat Transfer, by W. A. Spofford and R. H. Norris

8:00 p.m.

National Defense

Speakers on production, priorities, design conservation, civilian protection

Boiler Feedwater Studies

Symposium on Caustic Embrittlement:
Studies on the Cracking of Boiler Plate, by P. G. Bird and E. G. Johnson[1]
Field Data From the Embrittlement Detector, by E. P. Partridge, C. E. Kaufman, and R. E. Hall[1]
Summary, by W. C. Schroeder

WEDNESDAY, DECEMBER 3

9:30 a.m.

Plasticity

Plastic Flow as an Unstable Process, by L. H. Donnell[1]
The Mechanism of Cavitation Erosion, by T. C. Poulter[1]
Mathematical Theory of Plasticity, by R. von Mises

WEDNESDAY (*continued*)

9:30 a.m.

Power Session (II)

The Mercury-Vapor Process, by A. R. Smith and E. B. Thompson[1]
Mercury for the Generation of Light, Heat, and Power, by H. N. Hackett[1]

Textile

Engineering Characteristics of Various Fibers, by Werner Von Bergen
The Upper Limits of Temperature and Humidity for Fibers in Drying Operations, by Albert C. Walker

12:30 p.m.

Textile Luncheon
Technical Colleges and Their Relation to the Textile Industry, by Frederick M. Feiker
Student Luncheon

2:00 p.m.

Administrative Organization

Panel Discussion What Is Top Management Actually Doing About the Supervisory Problem

Speakers:
R. E. Gillmor
J. P. Kottcamp
R. F. Gow
H. W. Johnstone
Albert Sobey
R. O. Kennedy
Stewart M. Lowry

Power (III)

The Flow of a Flashing Mixture of Water and Steam Through Pipes, by Max W. Benjamin and John C. Miller[1]
Wind-Tunnel Tests on Chimneys for Riverside Station at Baltimore, by E. F. Wolf

Mechanical Springs

Relaxation Resistance of Nickel-Alloy Springs, by B. B. Betty, E. C. MacQueen, and Carl Rolle[1]
Symposium on Formulation of Code for Design of Helical Springs:
Scope of the Problem—What Does the Practical Spring Designer Need? by J. K. Wood
Design Stresses for a Standard Code, by A. M. Wahl
Spring Tables—Hints on Scope and Arrangement, by H. C. Keysor
Nomographic Charts—Advantages and Disadvantages, by L. C. Peskin
Further Research Work Required, by M. F. Sayre

6:30 p.m. Annual Dinner

THURSDAY, DECEMBER 4

9:30 a.m.

Rubber and Plastics (I)

Practical Aspects of Vibration Isolation by the Use of Rubber, by W. C. Keys
Advances in Rubber and Plastics During the Year 1941, by F. L. Yerzley and G. M. Kline

THURSDAY (*continued*)

9:30 a.m.

Fluid Mechanics

A Simple Air Ejector, by J. H. Keenan and E. P. Neumann[1]
Theory of the Ejector With Driving and Driven Fluids of Different Densities, by J. A. Goff and C. H. Coogan
Graphical Solution of Fluid Friction Problems, by E. S. Dennison[1]

Railroad—I

Symposium on How Can Mechanical Engineering Assist the Railroads in Meeting the Transportation Phases of the National Emergency?
Remarks by President William A. Hanley

Keynote Speakers:
C. D. Young
W. C. Dickerman
Four collateral speakers each covering individual phase

Education and Training (I)

The Fundamentals of Professional Education, by Elliott Dunlap Smith
What the Educated Don't Know, by Mark M. Jones
Organization and Administration of Engineering Courses, by H. S. Rogers
Visual Aids for Defense Training, by Floyde E. Brooker, Sr.

Hydraulic (I)

Structural-Steel Tolerances at Bonneville, by T. M. Ober[1]
Test Characteristics of a Combined Pump-Turbine Model With Wicket Gates, by R. V. Terry and F. E. Jaski[1]

Furnace-Heat Transmission (I)

Studies of Heat Transmission Through Boiler Tubing at Pressures From 500 to 3300 Psi, by W. F. Davidson, P. H. Hardie, C. G. R. Humphreys, A. A. Markson, A. R. Mumford, and T. Ravese[1]
Part I—Objectives, Apparatus, Instrumentation, Operation, and Records
Part II—(*a*) The Temperature Drop Through the Tube Wall Including the Wet Side Film; (*b*) The Shape Factor Related to Temperature Drop

Sugar

The Design, Construction, and Operation of Silos for Storing Granulated Sugar in Bulk, by Alex. M. Ormond
Some Practical Advantages and Disadvantages of Continuous Sugar Clarifiers, by J. M. Brown and W. A. Bemis
Preliminary Report of Committee on Char Values, by A. B. Babcock

Industrial Marketing

Industry's Search for Industrial Markets, by Elmo Roper
Discussion by Roland G. E. Ullman and Harry J. Loberg
Industrial Marketing and the National Defense, by Tell Berna[1]
Discussion by James Y. Scott and C. A. Norris

12:30 p.m. Railroad Luncheon

THURSDAY (*continued*)

2:00 p.m.

Railroad (II)

Railroad Progress Report, by E. G. Young
Open Discussion on The Importance of Standardization of Steam Road Locomotives and Freight Cars and Their Greater Utilization in Service, by Ralph Budd
Followed by Open Discussion

Education and Training (II)

Paper by P. W. Melton, Training Officer

Furnace-Heat Transmission (II)

Part III—The Pressure Drop Through the Tube
Part IV—The Pressure Drop Through Flow-Distributing Equipment Designed for Use in Forced-Circulation Boiler
Part V—Heat-Transfer Coefficients of Auxiliary Heat-Exchanging Equipment Used in These Investigations

Hydraulic (II)

Comparative Characteristics of Fixed- and Adjustable-Blade Axial-Flow Pumps, by J. D. Scoville[1]
Some Problems in the Selection and Operation of Centrifugal Pumps for Oil and Gasoline Pipe Line, by Aladar Hollander
Test for Centrifugal and Propeller Pumps, by G. F. Wislicenus

Materials Handling

Industrial Haulage—A Vehicle in National Defense, by Harry B. Clapp

Rubber and Plastics (II)

The Uses of Plastics in Various Ways in Airplane Construction, by H. N. Haut
Plastics, by G. E. Landt

Cutting of Metals

Correlation of Coefficient of Friction With Drilling Torque and Thrust for Different Types of Cutting Fluids, by A. O. Schmidt, W. W. Gilbert, and O. W. Boston[1]

Preprints of 1941 Annual Meeting Papers

AS USUAL, a considerable number of papers to be presented at the 1941 A.S.M.E. Annual Meeting to be held at the Hotel Astor, New York, N. Y., December 1-5, 1941, will be available in preprint form in advance of the Meeting.

The program of the Meeting which appears on pages 846-847 of this issue indicates the papers to be ready for distribution to discussers in advance of the Meeting. A few additional papers, received too late for preprinting in advance of this issue date, will be available at the sessions. Requests for papers should be addressed to the Secretary, The American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y. In so far as possible, orders received in time will be filled.

A.S.M.E. 1941 Annual Meeting Covers Broad Field of Technical Subjects

To Be Held at Hotel Astor, New York, N. Y., Dec. 1–5, 1941

FOR the third consecutive year The American Society of Mechanical Engineers will hold its Annual Meeting outside the Engineering Societies Building in New York. In 1939 a custom of long standing was broken when the A.S.M.E. held its national convention at Philadelphia instead of New York. This was one of the largest and most successful meetings ever held and it afforded an opportunity to increase the number of sessions and papers presented because of the increase in meeting-room facilities available at a large metropolitan hotel. Although the meeting was returned to New York in 1940, it was decided to hold the sessions at a hotel. As a result of last year's experience, the 1941 Annual Meeting will have as its headquarters again the Hotel Astor, where ample facilities exist for the holding of simultaneous technical sessions, committee meetings, luncheons, and other social events within the building which will also be the living quarters of many members from out of town. Technical sessions will commence on Monday evening, December 1, and will continue through Thursday evening, December 4.

Arrangements are being made for a convenient registration headquarters and to provide ample facilities for informal gatherings so that members will find ample opportunity to meet and converse with their friends in an atmosphere that will be reminiscent of the lobby of the Engineering Societies Building and detached from the regular activities of the hotel.

Council Meets With Delegates and Committeemen

As has been customary for many years, the Executive Committee of the Council will meet on Sunday morning, November 30, and following luncheon, the entire Council will hold its first session. Members of the Council, representatives of the Society's standing committees, and delegates to the conference from the local sections will gather for a buffet supper on Sunday evening, to be followed by an off-the-record discussion of Society affairs and a "get-together" for the purpose of better acquaintanceship. Executive Committee and Council meetings will be held at the Astor, but the buffet supper and the get-together will be at the Engineers' Club.

No technical sessions will be held on Monday until the evening so that the sections' delegates and members of the Council may have an opportunity to dispose of most of their business before the technical program gets under way. On Monday noon, in the ballroom of the Astor, the Annual Business Meeting of the Society will be called to order by President William A. Hanley, at which time the annual report of the Council will be presented and Society affairs will be discussed. R. E. Doherty, president, Carnegie Institute of Technology and chairman E.C.P.D., will deliver an address, "Professional Development and Responsibility."

> ### *Official Notice*
>
> ### A.S.M.E. Business Meeting
>
> THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held Monday afternoon, December 1, 1941, at 2:00 p.m. at the Hotel Astor, New York, N. Y., as a part of the Annual Meeting of the Society.
>
> (*Signed*) C. E. DAVIES
>
> *Secretary*

All day Monday has been set aside for sessions of the Sections' Delegates Conference, and on Monday afternoon the Professional Divisions will hold a conference for the discussion of their affairs.

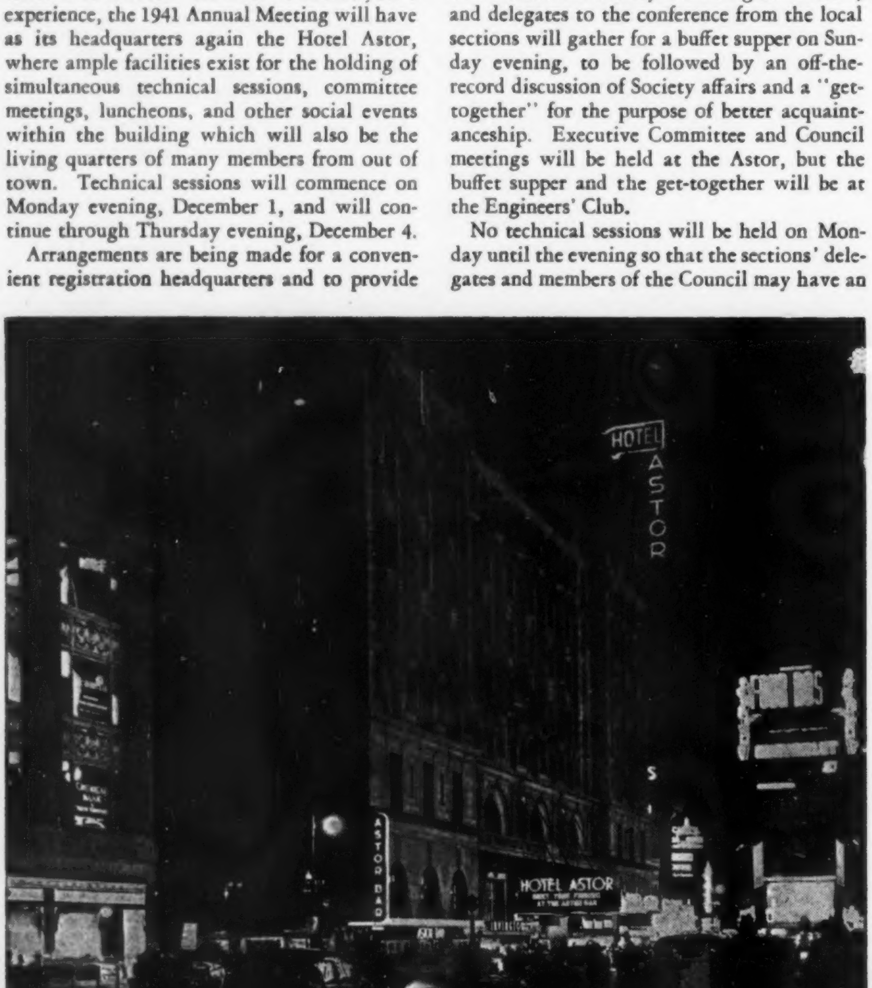
On Friday, December 5, at the headquarters of the Society in the Engineering Societies Building, the 1941 Council will conclude its business and the 1942 Council will convene for its first meeting. Mr. Hanley will introduce the new officers and members of the Council for the coming year, and James W. Parker, president-elect, will call to order the 1942 Council.

Technical Sessions Start Monday Evening

Technical sessions will open on Monday evening, December 1, at the Astor. Five simultaneous sessions will be held. The session of the Applied Mechanics Division on Monday evening will be devoted to papers on vibration. Four papers are scheduled for presentation.

Three papers on the general subject of work standardization constitute the Monday evening program of the Management Division. The authors are C. Canby Balderston, of the Wharton School of Finance, L. Clayton Hill, of the Murray Corporation of America, and Harold J. Ruttenberg, of the Steel Workers Organizing Committee. Discussion will be led by John R. Steelman, of the Conciliation Serv-

(*Continued on page 850*)



Cushing, N. Y.

TIMES SQUARE, IN NEW YORK CITY, AT NIGHT, LOOKING TOWARD THE HOTEL ASTOR, HEADQUARTERS FOR THE A.S.M.E. ANNUAL MEETING

ice, Washington, A. F. Hinrichs, Acting Commissioner of Labor Statistics, U. S. Department of Labor, and Robert A. Sayre, of the National Industrial Conference Board.

At the Fuels Division session on Monday evening the papers deal with pulverized coal. Henry Kreisinger and V. Z. Caracristi will speak on trends in design of pulverized-coal burners, and A. A. Orning on the combustion of pulverized coal.

The fourth Monday-evening session is sponsored by the Machine Design Committee of the Machine Shop Practice Division and will present two papers on widely different subjects. E. M. Bouton will review modern elevator practice and A. E. R. de Jonge will discuss what's wrong with kinematics and mechanism.

The fifth session, under the auspices of the Process Industries Division, will be devoted to the subject of drying.

Three Groups of Simultaneous Technical Sessions

Tuesday, December 2, affords three groups of simultaneous technical sessions, with six each in the morning and afternoon and one in the evening.

At a joint session of the Applied Mechanics and Aviation Divisions on Tuesday morning the subject of thin-walled structures will be covered in five papers, two of which will be presented by title only.

Mathematical statistics will be discussed in two papers at the Tuesday morning session of the Management Division. The Metals Engineering Division is presenting a paper on the physical properties of cartridge brass, by Royden S. Pratt, of the Bridgeport Brass Company, and on the Foren mill, for rolling seamless tube, by E. W. Wrage, of the Globe Steel Tubes Company.

The Power and Hydraulics Division combine in a session on Tuesday morning at which N. R. Gibson and H. M. Cushing of the Niagara Hudson Power Company will describe the Oswego power station, and S. Logan Kerr and Stanley Moyer, of United Engineers and Constructors, will present some hydraulic-engineering problems at the Philadelphia Electric Company.

Industrial instrument control will be discussed in two papers at the fifth Tuesday morning session.

A symposium of three papers on caustic embrittlement will head the list of six sessions scheduled for Tuesday afternoon, and will be concluded at an evening session on the same day with two more papers and a summary of this same subject. The mechanical properties of metals, sugar, and topics of interest to Machine Shop Practice and Aviation Divisions will be presented at three simultaneous sessions on Tuesday afternoon, while the fifth session will be devoted to lubrication, with a paper on centrally supported bearings and a symposium on thermal conditions in bearings. The Heat Transfer Division will sponsor the sixth session on Tuesday afternoon.

Textile Division to Hold Annual Luncheon

The technical-papers program for Wednesday schedules six simultaneous sessions for the morning and five for the afternoon. At noon the Textile Division will hold its annual luncheon.

Cushing, N. Y.

GEORGE WASHINGTON MEMORIAL BRIDGE ACROSS THE HUDSON RIVER FROM MANHATTAN TO THE PALISADES IN NEW JERSEY

The National Defense note will be dominant in two projected Wednesday morning sessions, one on substitute materials and the other on cast vs. welded tank hulls. Management problems in the aviation industry will come in for an airing at the session jointly sponsored by the Management and Aviation Divisions.

Three papers on plasticity and the mechanism of cavitation erosion make up the Applied Mechanics Division's Wednesday morning session. Simultaneously the Power Division will present two papers on the mercury-vapor process and the Textile Division two papers on fibers and fiber drying.

At the simultaneous sessions on Wednesday afternoon there will be two interesting symposiums, one under the auspices of the Management Division at which the topic will be "What Is Top Management Doing About the Supervisory Problem?" and the other, conducted by the A.S.M.E. Special Research Committee on Mechanical Springs devoted to questions involved in the formulation of a code for the design of helical springs. In addition to the mechanical-springs symposium a paper on relaxation resistance of nickel-alloy springs will be presented.

Papers on the flow of a flashing mixture of water and steam through pipes and on wind-tunnel tests on chimneys will be read at the Power Division Wednesday afternoon, while the Committee on the Effect of Temperature on Properties of Metals will present a final report on tubular creep tests and an interpretation of creep tests.

Railroad Division to Hold Symposium

A symposium on the question "How Can Mechanical Engineering Assist the Railroads in Meeting the Transportation Phase of the National Emergency?" will be conducted by the Railroad Division on Thursday morning. C. D. Young, vice-president, Pennsylvania Railroad and W. C. Dickerman, chairman, American Locomotive Company, will lead in the discussion. The symposium will be followed in the afternoon by a session at which the Division's annual progress report will be submitted, and two papers, on the standardization of steam road locomotives and standardization of freight cars, will be read.

In addition to the railroad session on Thursday morning there will be six others. The Committee on Rubber and Plastics of the Process Industries Division will present a paper on vibration insulation and a progress report on rubber and plastics. Three papers on fluid mechanics will constitute the program of the Applied Mechanics session. A notable list of four papers will be offered by the Committee on Education and Training for the Industries, supplemented by a second session held that afternoon, and industrial marketing will be the subject discussed in the two papers offered by the Management Division, Thursday morning session.

Four papers, two at the Thursday-morning session and two at the afternoon session, will make up the program of the Hydraulic Division.

Furnace-Heat Transmission Takes Two Sessions

Under the auspices of the Research Committee and with the cooperation of the Fuels, Power, and Heat Transfer Divisions, a report of studies of heat transmission through boiler tubes at pressures from 500 to 3300 psi will be delivered in five parts taking up the entire

(*Continued on page 852*)

What water means to the earth, lubricant means to a bearing — life itself. And as the mountain stream provides an abundant and constant flow of water, so the exceedingly large grease capacity of the "CARTRIDGE" BALL BEARING provides constant and abundant lubrication to its raceways and rotating elements.

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PRECISION BALL, ROLLER and THRUST BEARINGS

time of two sessions on Thursday morning and afternoon and will be presented by W. F. Davidson, C. G. R. Humphreys, A. A. Markson, A. R. Mumford, and T. Ravese of the Consolidated Edison Company of New York, Inc.

Other sessions on Thursday afternoon at which technical papers will be read will be sponsored by the Materials Handling Division, the Committee on Rubber and Plastics of the Process Industries Division, and the Committee on the Cutting of Metals. A session on marine power is scheduled for Thursday evening.

Social Program Brilliant as Usual

The varied social program of the 1941 A.S.M.E. Annual Meeting will be brilliant as usual, with the Annual Dinner and dance at the Hotel Astor on Wednesday evening offering the greatest attraction. A speaker of national prominence will address the dinner at which time honorary memberships, medals, and prizes will be conferred. A committee of the Woman's Auxiliary is preparing an attractive program to interest women in New York at the time of the Annual Meeting and every effort is being made to offer a variety of entertainment.

Luncheons, committee meetings, college reunions, informal gatherings, an art exhibit, and numerous plant trips are being scheduled as usual so that the 2500 members and guests will find no dull moments during the four full days. Of especial interest will be the Student Branch sessions and the luncheon of the student members with the Council, which will take place on Wednesday noon at the Astor.

Cushing, N. Y.

THE FIFTY STORY BUILDING AT NO. 1 WALL STREET IN NEW YORK CITY IS BACKGROUND FOR THE SPIRE OF OLD TRINITY, ONCE THE CITY'S TALLEST PEAK

A.S.M.E. Medals to Be Conferred at 1941 Annual Meeting

AWARDS and honors for the year 1941 will be conferred in impressive and appropriate ceremonies at the Annual Meeting of The American Society of Mechanical Engineers, to be held at the Hotel Astor, New York, N. Y., Dec. 1–5, 1941. Announcement of recipients of honorary membership in the Society, also to be conferred at the Annual Meeting, will be made at a later date. Recipients of the 1941 awards are as follows:

A.S.M.E. Medal to Theodor von Kármán, director of the Guggenheim Aeronautic Laboratory, California Institute of Technology, Pasadena, Calif., "for his brilliance as a teacher, his researches in elasticity and many fields of physics and mechanics, and his distinguished leadership in the fields of aerodynamics and aircraft design.

Holley Medal to John C. Garand, Springfield Armory, Springfield, Mass., "for his invention and development of the semiautomatic rifle which bears his name and has been adopted by the United States Army; a distinct contribution to our national defense."

Worcester Reed Warner Medal to Richard Vynne Southwell, professor of engineering science, Oxford University, Oxford, England, "for his many distinguished services to engineering and science through papers and publications in many fields including aeronautics, theory of structures, elasticity, and hydrodynamics."

Melville Medal to Roger V. Terry, hydraulic engineer, Newport News Shipbuilding and Dry Dock Company, Newport News, Va., for his paper "Development of the Automatic-Blade-Type Propeller Turbine."

Pi Tau Sigma Award to R. Hosmer Norris, General Electric Company, Schenectady, N. Y. This award is made annually for outstanding achievement in mechanical engineering.

Junior Award to John T. Rettaliata, assistant engineer, Allis-Chalmers Manufacturing Company, West Allis, Wis., for his paper, "The Combustion-Gas Turbine."

Charles T. Main Award to John Balun (University of Detroit), student engineer, General Electric Company, Schenectady, N. Y., for his paper "The Need and Possibilities of Participation by Engineers in Public Affairs."

Undergraduate Student Award to G. Walker Gilmer, III (University of Florida), junior engineer, Eastern Division, Pan American Airways, Inc., Miami, Fla., for his paper, "Center of Pressure Characteristics of a Marconi Yacht Sail."

Cushing, N. Y.

TWILIGHT ON THE EAST RIVER, NEW YORK CITY

(A view from Long Island City shore looking toward Manhattan Island with the Empire State Building dominating the sky line.)

Prominent Railroad Men to Take Part in A.S.M.E. Annual Meeting

MEMBERS of The American Society of Mechanical Engineers who attended the record-breaking sessions of the Railroad Division at the Society's 1941 Semi-Annual Meeting at Kansas City in June are looking forward in keen anticipation to the program scheduled for the 1941 Annual Meeting to be held at the Hotel Astor, New York, N. Y., December 1–5. Added interest attaches to the program, which comprises two sessions, morning and afternoon of Thursday, December 4, and a luncheon, because of the prominence of the speakers and the timeliness and importance of the subjects under discussion.

Railroads and National Defense

Present plans call for a morning session devoted to a symposium on the general theme, "How Can Mechanical Engineering Assist the Railroads in Meeting the Transportation Phases of the National Emergency?"

Among the keynote speakers will be William Carter Dickerman, chairman, American Locomotive Company, one of the outstanding figures in the railroad industry, and C. D. Young, vice-president, Pennsylvania Railroad Company, whose lines are carrying an increasing volume of freight for National Defense production. Both speakers are abundantly qualified to present the views of the railroads, the railway-supply industry, and National Defense plants on the important subject that the Division has assigned for the symposium. The session will attract engineers and executives from all three of these branches of our national economy and should set up another record to add to the growing prestige of the A.S.M.E. Railroad Division in the field of transportation.

It is also expected that the Society's president, W. A. Hanley, will address the morning session. Mr. Hanley has devoted the major portion of his addresses to engineers during the

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Registration Fee for Non-Members at the 1941 Annual Meeting

There will be a registration fee of $2 for nonmembers attending the 1941 A.S.M.E. Annual Meeting. For nonmembers wishing to attend just one session the fee will be $1. This is in accordance with the ruling of the Standing Committee on Meetings and Program.

Members wishing to bring nonmember guests may avoid this fee by writing to the Secretary of the Society before November 24 asking for a guest-attendance card for the Annual Meeting. The card, upon presentation by a guest, will be accepted in lieu of the registration fee. Guests are limited to *two per member.*

last year to efforts to awaken the nation to the seriousness of the threat to our American traditions and system of enterprise that lies in the fateful events taking place in Europe.

Budd to Discuss Standardization

Following the luncheon which will afford an opportunity for a "reunion" of present and former officers and members of the Railroad Division and an informal get-together of railroad and railway-supply engineers, the second session will convene at 2 o'clock.

Heading the afternoon session will be Ralph Budd, president of the Chicago, Burlington and Quincy Railroad Company, and at present Transportation Commissioner, The Advisory Commission to the Council of National Defense. Mr. Budd, who received the John Fritz Medal of the engineering societies a year ago, highest honor of the engineering profession in this country, will make general remarks on the importance of standardization of steam-road locomotives and freight cars and their greater utilization in service.

Many prominent railroad mechanical engineers and equipment-manufacturer's engineers have been invited to discuss these important aspects of standardization.

The annual progress report of the Railroad Divisionf or 1941 will also be presented at the afternoon session. This progress report has been a regular and popular feature of Railroad Division programs for several years. Prepared by Committee RR6 of the Division consisting of E. G. Young, chairman, B. S. Cain, and K. F. Nystrom, the report will be presented by B. S. Cain, of the General Electric Company, Erie, Pa. It is expected that copies of the report, preprinted from MECHANICAL ENGINEERING and profusely, illustrated will be available for distribution at the session.

A.S.M.E. Photographic and Graphic-Arts Exhibit During 1941 Annual Meeting

Technical and Nontechnical Subjects May Be Submitted Until November 28—Read Entry Requirements

THE Photographic Group of The American Society of Mechanical Engineers invites members and their friends to participate in the Sixth Annual Photographic and Graphic Arts Exhibit to be held at the Hotel Astor, New York, N. Y., in conjunction with the 1941 Annual Meeting of the Society, December 1 to 5. Subject matter whether technical or nontechnical is acceptable. Entry blanks may be obtained from A.S.M.E. headquarters.

Jury to Select

The photographic prints will be selected for medals and hanging by a jury of nationally known photographers. Entries in the Graphic Arts Section will be judged for medals and hanging by a panel of nationally famous artists. As an added incentive, entries, as selected by the editors of MECHANICAL ENGINEERING, will be used in that publication.

Cushing, N. Y.

A SUNSET SKY-LINE SILHOUETTE: FROM BROOKLYN BRIDGE

Any number of entries may be submitted although the Photographic Group reserves the right to select and limit the number actually hung, depending on the space available.

However, according to present indications, there will be plenty of space this year to take care of all. Unless specifically directed otherwise, in writing, the committee arranging the exhibit assumes that the entrant gives his permission to allow free reproduction of any print by MECHANICAL ENGINEERING.

In the Graphic Arts Section are included all forms of etchings, pencil drawings, lithographs, water colors, and oil paintings. All entries must be accompanied by an entry blank.

Photographic prints must be mounted on 16 × 20-in. light-colored boards in such a manner as to permit vertical hanging of horizontal subjects. On the back of each entry should be written the name and address of the member or friend submitting it and a notation as to whether or not the entrant is a member of the A.S.M.E. All submittals must be received on or before November 28, addressed to the A.S.M.E. Photographic Exhibit Committee, 29 West 39th Street, New York, N. Y. They will be returned as soon as possible after the close of the exhibit, except where withheld for subsequent reproduction in MECHANICAL ENGINEERING. These will be returned later by the editorial department.

Wrap Securely

To facilitate the handling of entries submitted, they should be protected with corrugated cardboard and securely wrapped. To save postage, the entries should be sent parcel post, insured if desired. Postal regulations forbid the enclosure of any letter or entry blank in the package but permit the attachment of it to the outside of the wrapping in a stamped envelope. Fifty cents must be enclosed as an entry fee.

All possible care will be exercised in the handling of exhibits, but no responsibility is assumed by the Photographic Group or The American Society of Mechanical Engineers for loss or damage in transit or during the exhibition. However, where entries are returned by mail, they will be insured if the sender forwards sufficient funds to cover the cost.